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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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The Engineer and the Foundry.

The excellent attendance at the last meeting of the Institution of Mechanical Engineers, when Papers by Mr. Pearce and Mr. Fletcher were given, illustrate the interest that the engineering world is now feeling about cast iron and the foundry. It is a great pity that the discussion did not rise to a higher level, for after interesting contributions by Sir John Dewrance, Mr. Cameron and Mr. Weeks, the remaining speakers contributed little of technical value. We understand that the Papers are to be read at various Branch meetings of the Institution, and we trust that the policy of inviting local members of the I.B.F. and of the Research Association will be continued.

We do not propose to refer in detail to the Papers or the discussion, as they are reprinted elsewhere. Mr. Pearce, in his introductory Paper, demonstrates that during a period of remarkable engineering development the output of grey iron has been virtually stationary, but he suggests that recent and future developments due to research work will result in its output increasing as steadily as that of steel has done—the present depression excepted—and is doing. All connected with foundries are concerned with the steady expansion of their industry, so that it may give greater output and yield to the manufacturer, chances of promotion to the more ambitious, and steadiness of employment all round. Some materials are so uniform in their properties and so unaffected by such considerations as rates of cooling in manufacture, that most of the experimental work they demand can be done in the laboratory. Cast iron, on the other hand, has to be produced in quantity, and hence the experimental work requires much greater organisation and planning.

Mr. Fletcher emphasises the light thrown on research work by defects and failures, and shows how important it is for the foundry engineer or metallurgist to be thoroughly acquainted with the practice of moulding and core-making. Some interesting illustrations are given of the value of scientific knowledge in foundry problems. The explanation of cracks near enclosed angles of cores is the exact reverse of the "Effet Leonard." The most important part of the Paper deals with the dendritic structure of ordinary cast iron due to the sudden cooling in the mould, which produces austenitic dendrites at right angles to the mould-face. These dendrites may in the subsequent cooling be converted to pearlite and graphite, but may retain their form, whereas the internal thick parts of the casting have the crystals completely mixed. The modification of Maurer's diagram is of great practical importance, and the whole Paper assists the metallurgist to see clearly the relation between the various special irons now being produced.

Sir John Dewrance clearly stated the duty of the draughtsman to make sections as uniform as possible, and to make changes in a section very gradual. Mr. Cameron suggested that, largely as a consequence of the work of the Association, the founder was now able to supply the engineer with castings of any required quality, tensile strength, heat resistance, and so on. Mr. H. B. Weeks commented on the tendency of designers to work without due regard to foundry requirements, but the engineers found a strong champion in Mr. George Reavell, in whose foundry a design is discussed between the foundry, pattern shop and drawing office before anything is put on paper.

We believe that the excellent work being done by the Institute of British Foundrymen and the great engineering institutions could be further enhanced by arranging for joint meetings at which points of common interest in design and foundry practice could be discussed. An actual concrete case might be studied with advantage, as either engineering or metallurgical generalities do not enable either side to get very far in appreciating each other's point of view.

XUM

Tumblers for Brass Castings.

BY "CELSIAN."

As the profitable production of good brass castings largely depends on the lowest labour-cost incurred in the foundry, it is surprising that more extensive application is not made of the tumbling barrel. The latter is a simple device, and efficient work can be accomplished by its employment as a cleansing factor. At one time it was presumed that brass castings could not be successfully treated in tumbling barrels. There are now, however, in use various types of this contrivance, by the intelligent use of which brass castings in many cases may be cleansed and brightened so successfully that buffing and polishing may be dispensed with.

Tumbling consists of filling or partially filling the barrels with castings, cleansing material and sometimes liquid. The whole mass is rotated for a specified period, and when properly proportioned will produce satisfactory work. Barrels are operated wet and dry. For the latter the packing materials are leather meal, sawdust, sized flint, etc., while for the former solutions of cleansing compounds are used.

Tumblers are made in various shapes and of different materials, each good in its own way and adapted to suit different kinds of work. They are made either round, oblong, and tilting or egg-shaped, with different numbers of sides varying from 4 to 20. For brass castings the cylinder and truncated cone shapes are commonly used. There exists great diversity of opinion with regard to the construction and management of tumblers. In some cases wooden material is preferred to iron. An iron barrel lined with wood is claimed by some to be peculiarly suitable for brass castings, whilst others contend that a brass-lined iron barrel gives excellent results.

The size of the barrel is also a matter for difference of opinion, founders, in some instances, considering that even when the number is considerable, castings are cleaned and brightened more quickly in small than in large tumblers.

Then, again, for brass castings direct from the foundry the wet method is often preferred to the dry, whilst in some cases the latter is considered equally applicable. There is no fixed rule, the various castings necessitating different treatment, each of them being a matter of experience and skill on the part of the founder.

Loading.

Loading the tumblers is an important factor. In a closed barrel the load should be seven-eighths full, the proportion of castings and material being about equal. It is not necessary to load fully a tilting open-topped barrel, as it can be tilted at different angles, and may be loaded as lightly or heavily as desired. If there are holes in the castings the cleansing material should not be of such a character as to become wedged into and remain in the holes. In the case of heavy castings, each weighing, say, about 30 lbs., treated in tumblers with a capacity of about 500 lbs., the latter should be partially filled with such material as foundry refuse, etc., to prevent the castings from injuring each other. The addition of cleansing material as heavy as the castings would prove disastrous, defacing the latter beyond recognition. A successful method of loading tumblers is as follows:—The castings are wedged in such a manner that they rotate with the barrel, thus preventing nicking and bruising and allowing the cleansing material to move very freely over the castings. This method permits of the tumblers being successfully operated in pits under the floor level.

Speed.

The speed at which the barrels rotate has a great influence on production. No matter what type of tumbler is employed the speed at which it rotates should never be great enough to prevent the work rolling on the ascending side of the barrel in order that the castings may not be held stationary by centrifugal force.

Although cleaning in barrels is spoken of as tumbling, rumbling, rattling, etc., the castings, in practice should do neither, but should roll as smoothly as possible. For this reason many founders advocate the oblique type of barrel, as its action is not rough on castings. By the employment of this method of cleansing, nicking and injury are reduced to the minimum, as the castings roll smoothly over each other instead of being carried over the centre of the barrel and dumped one on the top of the other as is the case in those of the horizontal type. The oblique type is commonly used for small and medium castings, but it should be quite suitable for work of larger dimensions.

The original water charged at loading time proves sufficient throughout the process for this type of barrel. It also acts as a labour saver since it has an open end through which the operator is enabled to inspect the work in progress. This is invaluable, as in no other way can the time for unloading be better ascertained, whereas in closed barrels guess work has to be resorted to, with all its disadvantages.

The time taken to clean castings is considerably reduced when a small proportion of sulphuric or hydrofluoric acid is added to the water.

More often than not the speed at which tumblers are allowed to rotate is too great. Tumbling barrels for sand-blasting may produce successful results by rotating once in half a minute, as that time is quite sufficient for the end in view, which is to expose each of the surfaces to the action of the blast. This speed, however, would be useless for tumbling generally, which work requires to be much more quickly rotated. One authority claims that over 60 revolutions per minute is too great, and that under 50 is too little, maintaining the opinion that the speed requires to be within these numbers for successful results. Another claim is that about 44 revolutions per minute is to be recommended for brass castings. Of course much depends on the weight of the latter.

The most efficacious and at the same time most economical period for unloading can only be acquired by experiment and practice with all types of tumblers and with different sizes of castings. When tumblers rotate too rapidly the consequences are serious, viz., high-power consumption, considerable water bills, badly damaged castings, and the necessity of frequently renewing barrels, staves, etc., not to mention loss of time through repeated stoppages. On the other hand when the speed is too low it requires readjustment, and necessitates the repetition of the whole process.

It is not claimed for tumblers that by their employment work is accomplished in less time than when conducted by hand. As a labour-saving factor, however, it is often the medium whereby work is produced at a profit instead of at a loss, since after being started the contrivance, among other advantages, carries on the work unaided.

Correspondence.

[*We accept no responsibility for the statements made or the opinions expressed by our correspondents.*]

Large Ingot Moulds.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—As a matter of interest, we forward the following brief description of an ingot mould which was cast in our Openshaw Iron Foundry on December 15.

The dimensions and weight of the mould are as under:—Internal diameter, top 72½ in., bottom 80 in.; external diameter, top 113 in., bottom 121 in.; length, 205 in.; and weight, 109 tons.

One hundred and thirty tons of molten metal were used to cast this. The metal was teemed into the mould in ten minutes, and the casting was afterwards fed for twelve hours. This is the largest mould which has been cast in our foundry, and probably one of the largest produced in the country.—Yours, etc.,

For SIR W. G. ARMSTRONG, WHITWORTH & COMPANY, LIMITED.
G. C. GRANT.

Ashton Road, Openshaw,
Manchester.
December 19, 1925.

[In February, 1922, the Brightside Foundry cast an ingot mould weighing 110 tons, the inside dimensions being 108 by 68 by 148 in. long. It was cast in 4¾ mins.—EDITOR.]

Making a Motor Road Roller.*

By Ben Hird.

Fig. 1 illustrates a casting for the hind roller of a Barford Perkins motor road roller. It is 4 ft. 6 in. long by 4 ft. dia., whilst the thickness of the perifery and ends is 2¼ in. This casting weighs 3 tons, but larger sizes weighing 5 to 6 tons are made. The weights often are required to vary in the same size of rollers. This is effected by adding extra thickness to the perifery walls, by making the diameter of the core smaller. There is a 12½-in. diameter hole at each end, and also a facing ring at the end, as is shown in Fig. 1. These are machined to a definite length-gauge to

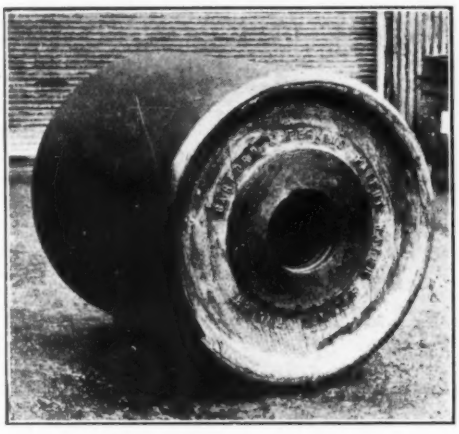


FIG. 1.—ROLLER FOR MOTOR ROAD ROLLER.

receive the gudgeon-pin castings. This is the only machining done to the rolls. The face of the perifery must be perfectly smooth and free from marks or swells. Therefore, the whole mould has to be wet blacked and thoroughly dried in a stove. The whole of the mould and core are rammed on a Mumford plain jolt ramming machine having a 6-ft. table and a lifting capacity of over 6 tons. They are finished and blacked by skilled moulders. At the opposite end to the one shown on the illustration a 1½ in. diameter thimble or union with internal thread is cast in at the inside edge of

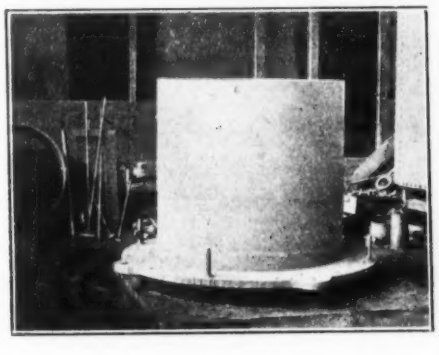


FIG. 2.—C.I. CYLINDER USED AS PATTERN FOR MIDDLE PART.

the beading. This is used for filling the roll with water, which is used as ballast when heavier weight is required; it is plugged with an ordinary gas plug.

Fig. 2 shows the cast-iron cylinder which is used as a pattern for moulding the middle part of the mould; it is about 2 in. thick, and machined inside and out with a very slight taper on the outside. The four small holes in the top edge of the pattern are for inserting hooks to draw the pattern from the mould; this is done with the aid of a crane, the pattern being well rapped on the inside with wooden mallets before and during the operation.

The table of the jolting machine is seen projecting about 2 in. above the floor level. On the table of the machine a cast-iron ring 5 in. deep and 2½ in. thick, machined true on both edges, is placed. This is designed to take the pattern plate, which has lugs cast on and machined accurately with the centre, which engage the cylinder and hold it in position. On the other side is the pattern for moulding the top and bottom ends. The projecting round edge of the pattern fits easily inside the ring and helps to prevent any tendency of the pattern plate to slide off the ring.

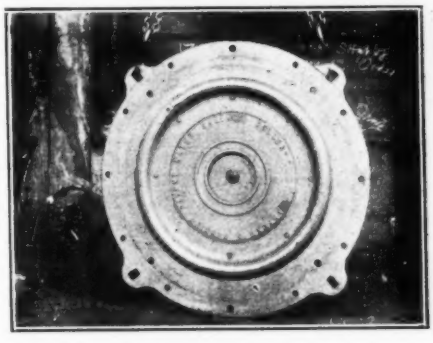


FIG. 3.—PATTERN PLATE FOR THE ENDS OF THE ROLLER.

The four pins for setting the middle part of the box are drilled radially with the centre of the plate, and slotted for cotters, which are used for holding the box to the plate.

A 5-ton electric crane operates over the machine. There is also a 10-ton crane in this moulding bay. The two cranes co-operated to handle this job, and any others that happen to be under construction in the bay.

Arrangement of the Bay.

The jolt ramming machine is at the bottom end of the bay, quite close to the sand-mixing plant. In the centre of the moulding bay, finishing and

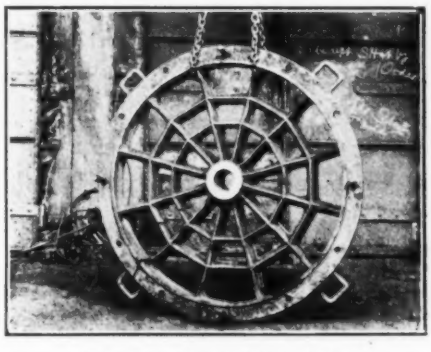


FIG. 4.—BOTTOM-PART BOX.

casting of the moulds is carried out. Near the top end are two large core stoves, and next to these at the very top end are the cupolas—one small one of about 24 in. inside diameter, and a larger one 36 in. diameter next to it. The large roll moulds are finished and blacked opposite to the stoves, and assembled and cast opposite the cupolas.

In Fig. 3 is shown the other side of the pattern plate, which is used for making the top and bottom parts of the roller. The part forming the round edge is detachable, so that it can be changed when square edge or slightly different sizes are required. The recess in the centre takes

D

* A Paper read before the Wales and Monmouth Branch of the Institute of British Foundrymen at Newport, Mr. P. Leonard Gould presiding.

the centring boss of the bottom-part box. When making the top part, a centre pin about 10 in. dia. is located in the centre hole (as is shown in Fig. 4), and through which the core is held down and the gases escape. The facing piece is a loose wood ring located in the centre of the raised beading.

Moulding Box for the Bottom Part.

In the centre of Fig. 4 is shown the boss, which is bored with a good taper and faced true for receiving the centring pin of the core, when the job is being cored up. The bars are wedge-shaped in section, the thin edge being nearest the pattern, to allow the sand freedom to pack under the bars when being jolted. The top-part box is very similar, with the exception of the centre, which

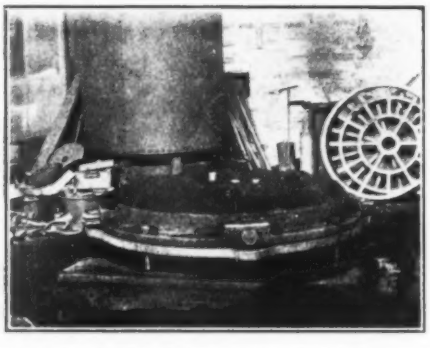


FIG. 5.—TOP PART FILLED WITH SAND READY FOR JOLTING.

is a plain ring bar about 12 in. dia. The boxes are split through the edge and bars to allow for expansion and save them splitting in a more inconvenient place. As will be seen, the stout box handle acts as a cramp at this place. The pins are cotter-pins, and the holes round the edge for extra bolts for securing up before casting.

The top part is shown in Fig. 5 filled up with sand ready for jolting. The same ring that is used to support the middle-part plate is placed on the jolt table, the pattern plate put on this. The runner pegs are set on the loose facing ring,

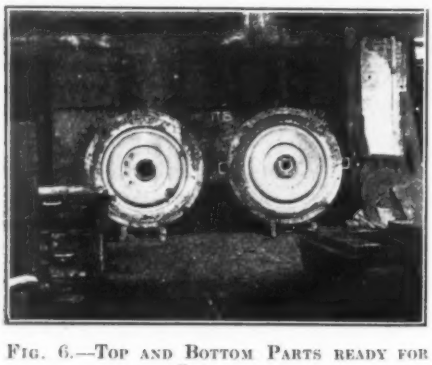


FIG. 6.—TOP AND BOTTOM PARTS READY FOR STOVING.

and the guide pin put in the centre. About 1½ in. of sand is riddled on over the face, the edges of the plate, where the box takes a bearing, swept clean, and the box bedded on and firmly cottered down through the pins. A few lifters are put in here and there to help to hold up the top during casting, and sand is filled in to 4 or 5 in. above the top of the bars, to allow surplus sand for jolting. The mould is then jolted about sixty to seventy jolts, the loose sand left on top is gone over with a flat rammer to tighten it, and then shovelled off level with the bars. The mould is then lifted off with the crane and taken away down the shop for finishing and blacking. The bottom part is made in almost the same manner. After the facing sand has been riddled on, the centre is cleared to allow the machined boss to take an iron to iron bearing on the plate.

In Fig. 6 is shown the top and bottom parts finished and blacked ready for putting into the stove. The left hand is the top and the right hand the bottom. On the top part in the facing piece are four runners and the riser off the top of the rounding edge. At the bottom left-hand corner is the threaded thimble, through which the roll can be filled with water for ballast. The projecting ring of sand round the centre hole takes a bearing on the core, which takes a bearing on a similar ridge on the bottom part, but the weight of the core is taken on the metal boss in the centre.

The middle part, shown in Fig. 2, as has already been explained, is the cast-iron cylinder pattern in position on the plate. Before putting on the middle-part moulding-box, the outside pattern is well wiped over with a piece of waste soaked in paraffin.

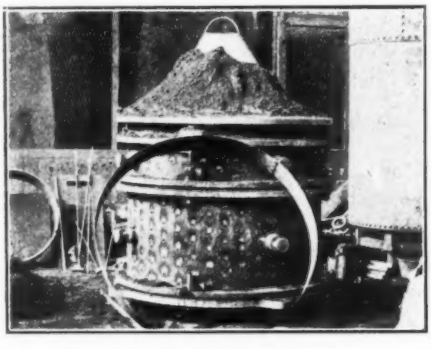


FIG. 7.—JOLTING UP THE MIDDLE SECTION.

The middle part is shown in position in Fig. 7, filled with sand and almost ready for jolting. The box part is built up of three separate sections. This was done for the purpose of adapting the boxes to suit various lengths of rollers. Small holes were drilled in the boxes for vent and to allow steam to escape during drying. There

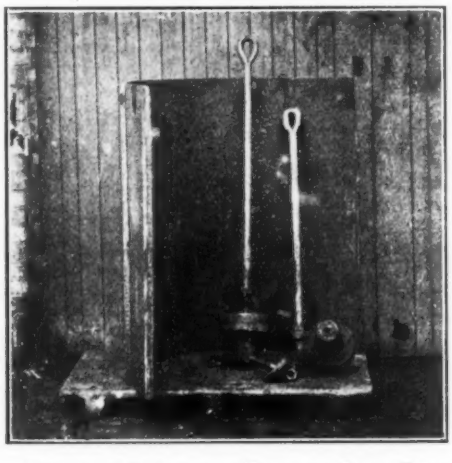


FIG. 8. C.I. CENTRING BOSS AND LONG EYE-BOLT FOR CARRYING THE CORE.

are four stout equally-spaced trunions for handling purposes.

The conical arrangement surmounting the mould is made of sheet iron, and is placed on the top of the cylinder pattern to prevent the sand falling inside, and to provide a feeding head of sand while the mould is being jolted. The sheet-iron ring in front is placed on the top edge of the box to further assist in making this head of sand. When the sand has been piled up as high as possible and jolted, a second filling and jolting is necessary to ram the mould to the top. The first ramming settles the sand to about the top of the first joint; about sixty jolts are given to each ramming. The cone and ring are then removed, and the top edge finished off with a flat rammer. The mould and plate are removed down the shop for drawing the pattern and finishing the mould. So tightly is the sand packed, that one instance is recalled where the pattern, for some cause or

other, had been left in the sand overnight; it clung to the pattern, and came out with it, stripping away from the sides of the box almost clean.

Core-making.

The making of the core is carried out on the jolt machine. For some months after the moulds had been successfully made, the cores were still rammed by hand. It was thought, if the outside could be rammed, so could the inside, and after trial it was found to be quite successful. Fig. 8 shows the cast-iron centring boss and the long eye-bolt for carrying the core. The iron boss

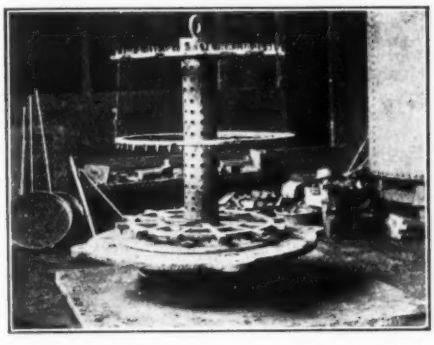


FIG. 9.—SKELETON FOR CONSTRUCTING THE CORE.

is machined with taper on the small part, and faced true on the underside of the large part, it is tapped to take the small eye-bolt at the bottom and the long eye-bolt at the top. The tapered part is made an easy fit in the hole in the centre of the bottom part shown in Fig. 7. The curved sheet-iron plates are placed inside the cast-iron cylinder pattern to form the outside diameter of the core; these are made to various diameters to suit the thickness and weight of the roller as required.

The skeleton of the core is shown in Fig. 9.

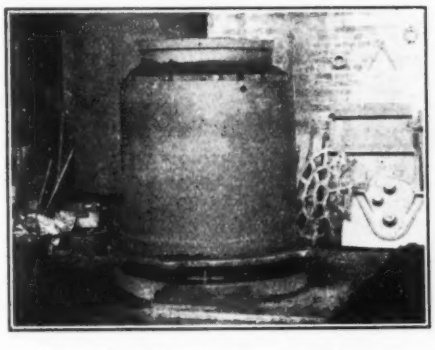


FIG. 10.—WITHDRAWING THE CENTRE CYLINDER.

and, like some other skeletons, part of it has been wired up, which explains the apparent suspension in mid-air of the centre ring. On the jolting table a ring about 11 in. deep is placed to allow for centring pin and small eye-bolt, which projects thorugh the core plate; the centring pin is placed in a hole in the core plate just large enough to admit the small part, and securely fastened underneath with the small eye-bolt and washer. The hole for the long eye-bolt is plugged with waste. The cylinder pattern is now placed on the plate, and located by the raised pieces projecting above the plate. The two semi-circular sheet-iron plates for forming the thickness are placed inside, and sufficient sand shovelled in to allow for well bedding down the bottom core iron. The loose sand is cleared of the top of the centring pin, the waste taken out of the screw hole. A washer sufficiently large to engage the core iron is placed on the centre, and the large eye-bolt screwed down until its collar tightens on to the washer. More sand is thrown in and rammed by hand to about 2½ in. above the core iron. A smaller iron cylinder pattern is now placed in position in the centre, allowing space for about 3 in. of sand all round, which is now filled in level to the top, and the centre-core ring placed on this. When the core is jolted the ring settles with the sand to about a central position. More sand is filled in, and the core jolted solid to the top. The centre cylinder is then withdrawn (Fig. 10).

The vent barrel is now set in position and the centre space filled up with coke, which is given a few jolts to pack it. The coke and sand are now levelled off to just below the top of the vent barrel, and the top core iron bedded on.

The small cup or ring, set centrally on the core

FIG. 11.—THE DRIED CORE READY FOR ASSEMBLING.

iron for packing to hold the core down, when closing the mould. Sand is now thrown on, and the ramming of the top face of the core is finished by hand, and strickled out to allow for the 2½ in. of thickness at the top end of the cylinder. The plate shown below the bottom core-iron forms the thickness at the bottom end (Fig. 9). The whole is now carried down the shop on the core plate by the crane, the cylinder pattern withdrawn, and the two half-circular sheet-iron pieces taken away. The core is finished and blacked by the moulders and put into the stove on the plate to dry. Two

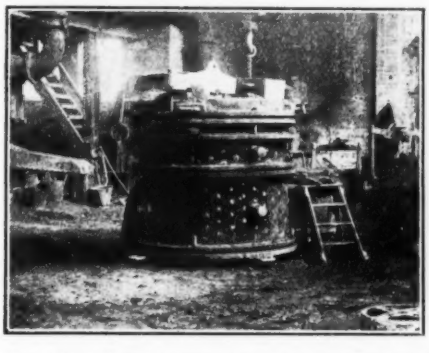


FIG. 12.—THE ASSEMBLED CORE READY FOR CASTING.

ribs for extra strength are cut by hand round the core.

Fig. 11 shows the dried core removed from the core plate and ready for lowering into the mould. The centring pin can be seen resting on the block.

The assembled mould is shown in Fig. 12, ready for pouring. The bridge across the top is holding down the core, which is packed on to the iron ring set into the top of the core by similar rings and wedged to the bridge.

To Put Wood Screws in Hard Wood.—Wood screws may be put into the hardest of wood by the following process:—A screw of the same size to be used is ground down to the form of a half-round bit: in other words, a tap is made of it. A hole, equal in diameter to the size of the screw at the bottom of the thread, is drilled into the wood, and the half-round tap is screwed in. This cuts a good thread, into which the screw may be easily screwed. Before introducing the screw, give it a good greasing with tallow so that no binding will occur.

Some Applications of Research to Modern Foundry Practice.*

By J. E. Fletcher, of Dudley, M.I.Mech.E.

The ease with which cast iron in pig or scrap form is re-melted and cast, and the liberal distribution of British moulding sands, possessing exceptionally regular and excellent refractory, adhesive, and porous properties, have made iron-founding a common art here for many generations. So common, indeed, that the kindly metallic fluid, which so readily filled the most intricate mould and congealed with little apparent defect within or without, invited but little scrutiny, and, so long as the frozen metal was considered strong enough for structural employment, the founder's product was accepted without demur.

A long experience in the foundry industry, however, compels admiration for the craftsmen who, scorned as a class, found for themselves the means whereby the countless pitfalls in moulding and casting might be avoided; in days when no metallurgical knowledge was available, and when the average foundry was "gloomy as a dungeon, draughty as a moorland barn, and insanitary as a Flemish farmyard." Rumour has it that there are a few such foundries in Britain even to-day.

Yet, notwithstanding the discouraging environment in which the founder has practised his art,

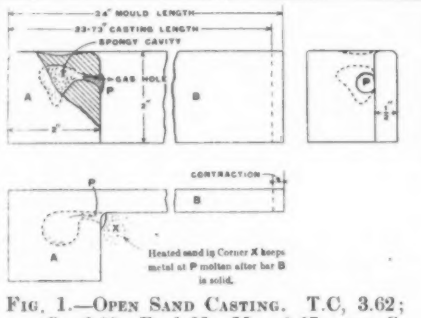


FIG. 1.—OPEN SAND CASTING. T.C, 3.62; Si, 2.95; P, 1.33; Mn, 0.67; AND S, 0.08 PER CENT. (NOTE.—BOSS A DID NOT MOVE DURING SOLIDIFICATION OF METAL. BAR B CONTRACTED TOWARDS BOSS A.)

difficulties have been bravely faced, and cold necessity has called out a mass of resourcefulness, not to say invention, such that the British moulder and caster holds a pre-eminent place in the world's foundry trade. When it is remembered that perhaps at least 70 per cent. of casting defects may be traced to causes associated with the craftsmanship of founding, it will be more readily understood how important is the study of the technique and what may be termed the severely practical side of foundry industry. In justice to this industry, recognition of the resourcefulness and skill of the average moulder and caster is much overdue, for, without such practical aptitude, the manipulation of perfectly fluid metal and excellent moulding materials would result in a succession of waster castings.

In the mass production of a specific casting many initial failures are looked at in the light of experiment, and sooner or later the best method of moulding and casting is arrived at and adopted. But in the engineering jobbing foundry such trial and error methods are inadmissible and commercially disastrous, hence the need of managerial guidance of the most skilful type.

The Cast-Iron Research Association found itself, from its earliest days, face to face with the usual difficulties associated with shop practice, as well as those belonging primarily to the fundamental properties of cast iron as a metallurgical problem of more particularly scientific interest. It was clear that both phases needed study as being inseparably connected, and that all foundry research must be practical in character, the interpretations of the results being necessarily in terms of possible and practicable utility.

In Britain, as in most other countries, the jobbing foundries are located in areas separately interested in definitely segregated industries, and may be concerned with chemical, agricultural, textile, marine, electrical, or other branches of engineering. The character of the moulding sands, refractories, fuel, and pig-iron commercially available in each area varies, as does the type of labour and moulding methods. Hence the production of similar castings made from different metal mixtures, moulded in different types of moulding sands by different methods, often results in correspondingly different types of moulding or casting defects, the remedies for which may involve very diverse methods of treatment.

It is only by setting up a kind of clearing house where common difficulties can be considered that, with the special help of the members interested in a specific problem common to widely separated areas, scientifically rational solutions can be arrived at, based on the fundamental reasons for the troubles.

The mass of practical information on allied problems so far collected has made it possible to extricate gradually many families of difficulties and defects from a morass of long-standing evils. The scrap heap is a great teacher, and it can be stated with confidence that many steps in the direction of fundamental research on the properties of cast iron have resulted from the study of what looked, at first sight, a common and uninteresting works problem. Many of the apparently mysterious casting defects cannot be reproduced, either in the foundry or laboratory at will. The investigation of such defects has from time to time solved old problems of fundamental importance, and not infrequently opened up fresh avenues of research hitherto undreamed of.

In dealing with the complex alloy, cast iron, the importance of close observation, unremitting and continuous, of the unexpected happenings in metal smelting and founding, on the spot, cannot be estimated. In ferrous metal practice the correlation of such results, collected at the blast furnace, cupola, air furnace, steel-melting furnaces, and at the puddling furnace, is invaluable.

Abnormal iron fractures collected from the blast furnace pig bed, after some unforeseen accident at the furnace; the association of a peculiar slag with a certain iron composition and physical structure at the cupola, air furnace, or puddling furnace; an excessively high or low rate of contraction in a steel casting following accidents in the melting or pouring; are typical examples of occurrences which have been responsible for years of investigations along lines which have finally resulted in improvements in smelting, melting, and casting practice. Such work goes hand in hand with research of purely scientific character, and the Cast-Iron Research Association has felt the urgent necessity, in dealing with so practical a science as that of iron founding, to attempt the correlation of the works and laboratory sides of research by neglecting neither.

In this Paper the author seeks to illustrate, in some detail, a few examples of the type of work and method of attack used in applying the results of research to current foundry practice.

Skin Defects, Shrinkage and Contraction.

Any investigation into the characteristics of cast iron must recognise that the metal is a cast product, often of intricate form and of variable thickness. The vitally important character of the skin of a casting is largely dependent upon the satisfactory qualities of the mould material and

* Paper read before the Institution of Mechanical Engineers.

of its facing, the physical condition of which is of supreme importance.

The mould surfaces, with those of the metal in contact therewith, must be stressed differentially as the flow of the iron progresses, and, if the mould face is fissured, however minutely, the metal, when sufficiently fluid, may be similarly fissured at its surface, the thin skin being thereby weakened during the contraction period, at a time when the metal has little physical strength.

The difference between two portions of a mould surface, one tightly and the other lightly rammed, by hindering and assisting respectively, the flow of the gases liberated during the solidification of the metal, may lead to differences in the rate and amount of contraction and cause skin strain or fissure.

The presence of slag or oxide inclusions in such areas of the mould surface may easily intensify the skin fissure trouble, and not infrequently such fissures are seen to start from a slag spot.

A wrongly-placed runner gate may result in one portion of a casting contracting more rapidly than another, with the accompaniment of internal stress due to the formation of two types of metal structure, as a result of the different rates of cooling, and the casting may warp in consequence of the differential skin or envelope contractions.

The chemical composition of the liquid metal may be all that is desired, the temperature of casting correct, and the mean analysis of the cold casting such as would be deemed satisfactory; but, if the mould is carelessly rammed or vented, badly gated and poured, the casting skin cannot be uniformly perfect, nor can the metal structure be homogeneously regular nor the casting be free from internal stresses when cooled.

Obviously, the design and form of the casting must play an all-important part, and from the above it will be realised that the technique of the moulder and caster and their judgment are of paramount importance.

A little consideration will show that the mean chemical analysis or micro-examination of isolated spots in the structure are often of little service in discovering the cause of a failure, unless the relationship between the structure of the metal, the design and method of gating, running and feeding of the casting are known.

As the skin of the outer envelope of a casting is generally the starting point for fracture when subjected to tensile or impulsive stresses, the cause of the casting failure may not be revealed by a tensile, transverse or impact test imposed on bars cut from the casting, even when taken from the starting point of the fracture. The micro-examination at such spot may not, and in cast iron rarely does, indicate whether overstrain has taken place, there being little or no elongation of cast iron under the breaking stress.

The presence of graphite in all grey cast iron is, of course, responsible for the general absence of ductility, but the skin ruptures which occur in the plastic range of cooling, and cannot be healed by any known heat treatment, are generally difficult to trace; hence the history of the casting manufacture must be known when investigating the cause of external and internal defects. The contour of a casting, being related to variations in skin cooling rates, due to the character and temperature of the mould facing sand and to methods of gating, rate of pouring and influenced by differential rates of cooling where the form and thickness of the section varies suddenly, must be taken into consideration.

The foundry metallurgist must, therefore, be thoroughly acquainted with the practice of moulding and casting. He must possess the practical sense necessary to enable him to visualise the effect of altering the physical character of the mould surface and its mass, or of changing the method of gating, and pouring the casting on the external and internal portions of the metal mass. Without this practical sense fully developed, the metallurgist is often at a loss in his attempts to guide the efforts of the foundryman.

Again, the perfect solidity of a grey-iron casting is related to its rate of solidification from the outside to the inside of its thickness and to the efficacy of the feeding of the interior of the section last to freeze. When a thick and thin section join one another in a casting the interior of the thick section will be porous, unless the gases liberated within the metal during its solidification can escape readily to the rising heads from the thinner section. Otherwise the thick section becomes a feeder to the thinner, and the former is left porous because of the loss of metal used for feeding the latter.

Liquid metal under a sufficient pressure head in a riser large enough to remain fluid until the casting is solid obviates this difficulty when the variably thick sections are at the bottom of a deep casting, but when these occur at the top, as cast, the lack of sufficient fluid pressure head, due to the absence of amply deep and massive feeding risers, for example, will lead to sponginess or cavities in the thick sections, often of a serious character.

The design of a casting is often such that the temptation to mould and cast the wrong way up is too great, or a pattern may be so made that the same error is followed, through an attempt to cheapen the making of the pattern.

Wherever spongy areas occur in poorly-fed thick sections adjacent to thin ones, as in thick bosses

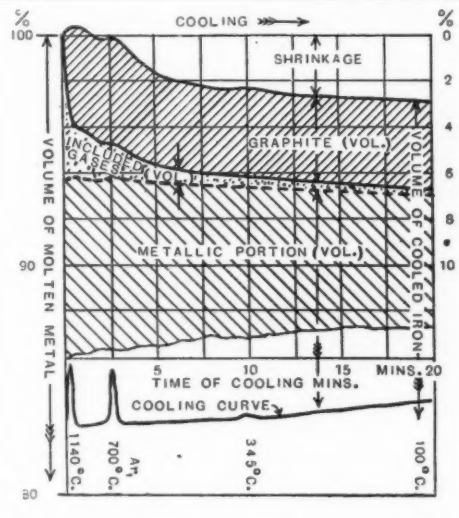
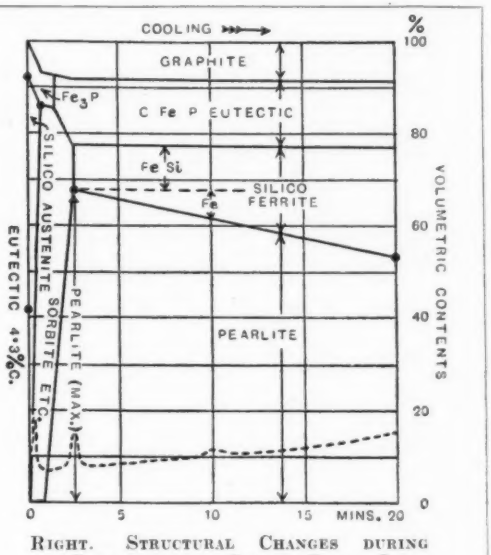


FIG. 2.—LEFT. VOLUME SHRINKAGE OF GREY CAST IRON 1 IN. THICK (TYPICAL).



RIGHT. STRUCTURAL CHANGES DURING COOLING OF GREY CAST IRON. ANALYSIS:—C, 3.5; SI, 3.0; P, 1.0; MN, 0.5; AND S, 0.06 PER CENT.

in thin plates, there is always a tendency for gas paths to form between the cavity or spongy area and the outside of the casting. The gases pent up in the cavity expand, and find a way through the metal generally by way of the corner angle, where the thick and thin sections join. The sand in such corners becomes heated to the temperature of the metal, and acts as a heat retainer, the metal surrounding the corner being thereby held in the molten state, through which the gas under pressure in the internal cavity escapes to the atmosphere. In Fig. 1 a bar ½ in. by 2 in. adjoins a metal mass of 2 in. cube. The casting was open sand cast, and, there being no feeding head over the 2-in. thick section, a gas cavity formed within this heavy mass. On the freezing over of the top crust, the gas liberated during the solidification of the still molten interior attained sufficient pressure to escape by way of a channel communicating with the internal corner between the thin bar and the cube, through the molten metal surrounding the hot sand in the corner which sand had acted as a heat retainer. The metal was high in phosphorus content, and hence contained as a constituent a considerable volume of the carbon-iron-phosphorus eutectic, which is the last constituent to solidify, freezing at about 945 deg. C., whilst the main constituent freezes at about 1,145 deg. C. The high gas pressure in the cavity had ejected some of the phosphide eutectic through the gas-hole formed previously, the bead of eutectic being shown at P in Fig. 1. The effect of the gas-pressure is also seen in the rounded upper surface of the casting.

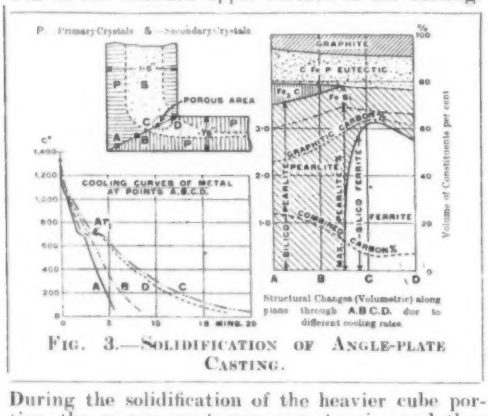

P. Primary Crystals S. Secondary Crystals
POROUS AREA
COOLING CURVES OF METAL AT POINTS A.B.C.D.
GRAPHITE
C. Fe P EUTECTIC
PEARLITE
FERRITE
CARBON %
Volume of Constituents per cent
Structural Changes (Volumetric) along plane through A.B.C.D. due to different cooling rates

FIG. 3.—SOLIDIFICATION OF ANGLE-PLATE CASTING.

During the solidification of the heavier cube portion the upper crust was seen to rise and then fall immediately after the small gas jets had ceased to blow through the plastic crust, leaving a shrinkage hollow over the cavity.

Had the mould been covered, and a riser equal in diameter to that of the cavity been employed, the casting would have been sharp-cornered, and, if the sand in the internal corner had been hard rammed, gas escape there would have been avoided. The slow cooling of the metal surrounding the corner would lead to a coarser crystalline structure, rich in graphite and prone to contraction cracks in the skin.

Another point of fundamental importance is shown in the same Fig. 1, and, though elementary when applied to this simple form of casting, is often neglected when more complicated forms are studied. The thin part of the bar contracts towards the heavier end, which remains stationary. Another bar of similar length, with a cube-shaped boss at each end, fractured at the internal corners, the thin bar being separated from the two bosses when removed from the mould. When cast on end a similar double-bossed bar fractured at the shoulder under the top boss, the liquid pressure head having prevented the formation of a gas cavity in the lower boss, though there was considerable porosity and shrinkage in the upper one.

The importance of remembering that contraction during cooling is in the direction of the heavier slow-cooling masses in a casting is obvious, and often assists a foundryman in deciding on the correct method of moulding, gating, and running a casting.

The influence of sharp internal corners, and the effect of the heat-retaining sand in promoting porosity and coarse-grained weak metal there, with skin fissures at this weakest spot, is common enough, but the same defects occur even more frequently in cored castings, where the cores are much thinner than the wall of metal surrounding them.

In Fig. 2 the progress of volume change and shrinkage in a casting is plotted against the temperature changes, as shown by the cooling curve of the metal. The progressive variation in the structural composition of the metal as it cools is also depicted, the whole of the curves being plotted over a time-base. Professor T. Turner was the first to show accurately the relation between the volume changes during and after the solidification of cast iron and the shrinkage of the metal. Recent experiments have confirmed his conclusions with respect to the influence of graphite separation near the freezing point, and later, at the pearlite point during the solidification of grey irons.

The structural composition of a grey phosphoric iron, quenched at different temperatures during the cooling from the melting point to about 200 deg. C., are also plotted above the cooling curve and time-base. Attention should be drawn to the volumetric expansion due to graphite separation immediately following the freezing point, and to a secondary graphite separation at or near the pearlite point (about 700 deg. C.). Perhaps the most interesting point recorded in the graphs is the fact that the highest rate of shrinkage of such grey cast iron occurs between the austenite and pearlite points (1,050 deg. C. and 700 deg. C.), in the comparatively short time interval of less than three minutes in the case of 1-in. thick material. In thicker metal the cooling rate of the interior is lower, but it is certain that when cooled in a cold mould the skin contraction during the time the metal is above the red heat is very rapid, and in lower silicon iron may readily lead to serious skin fissuring. It would appear from Professor Turner's research, and from the author's observations, that the greater volumetric expansion of high silicon phosphoric irons, which is not complete until the metal has fallen to below 700 deg. C., saves the skin of the castings, though internal unsoundness and porosity may give trouble in castings of variable thickness. The variable rates of cooling at different points within the mass of a grey-iron casting containing 3.5 per cent. total carbon, 3.0 per cent. silicon, 1.0 per cent. manganese, and 1.0 per cent. phosphorus, are illustrated in Fig. 3. An angle plate section is shown, four points in the corner diagonal being taken for the purpose of indicating the structural changes due to different rates of cooling.

The constituents in the cast iron are given in volume percentages, these values being calculated from the chemical analyses of the metal at the four points in the section. This method of expressing the composition of cast iron in terms of the constituents has been used by the author for some years, but it has only been possible to obtain approximate values for the volume percentages of the constituents until recently, the various specific gravity values being still somewhat uncertain in some cases. The graphs show very clearly the effect of various rates of cooling on the metal structure. Attention is specially directed to the graphite and ferrite volumes in the metal nearest to the internal corner, where slow cooling has resulted in the graphitisation of the carbides originally present in the fluid iron.

(To be continued.)

New Companies.

Croydon Bell Foundry, Limited, 43, Whitehorse Road, Croydon.—Capital £1,000 in £1 shares. Directors: C. F. Johnston and Mrs. Amelie C. Johnston.

Sjostrom, Limited, 134, Thornton Road, Bradford.—Capital £1,000 in £1 shares. Ironfounders. Directors: I. L. Sjostrom, R. L. Sjostrom, and Miss I. Robertshaw.

Sussex Foundry, Limited.—Capital £1,000 in 950 preference shares of £1 and 1,000 ordinary shares of 1s. Directors: F. Carter, 17, Silverdale Road, Hove; A. G. S. Jarvis and H. O. Russell.

Cast Iron and Modern Engineering Practice.*

By J. G. Pearce, B.Sc. (Eng.), Director, British Cast-Iron Research Association.

Introduction.

During the last few years a remarkable change has taken place in the development of cast iron. The commonest and cheapest of all structural ferrous materials, it has always been metallurgically neglected, and its replacement by competing ferrous and non-ferrous materials in engineering practice appeared formerly to be only a question of time. To-day cast iron is regularly produced in foundry cupolas from a wide variety of raw materials with great consistency and economy. Certain applications which had temporarily been usurped by steel and other materials are reverting to cast iron, and in some engineering developments that are now proceeding rapidly, notably in internal-combustion engineering, the development of the material is keeping pace with the growing demands of the engineering designer. The reason for this change is that metallurgical knowledge and experience, formerly almost exclusively devoted to steel and certain non-ferrous metals, is now being applied to cast iron, and this movement is taking place in all the principal industrial countries. Undoubtedly it had its origin in certain war-time conditions, which compelled founders to exploit much more fully than usual both the limited raw materials at their disposal and the resources of foundry practice.

During the past ten years the development of the material, although limited, has been almost continuous. As a consequence many theories hitherto held by founders are being challenged with considerable success. In America, experimental blast-furnace research is being conducted, and developments are taking place in methods of continuous production and in the production of castings in semi-permanent moulds. In France, an interesting specialised Technical High School has been established by the joint action of the Government and the Ironfounders' Association for the training of foundry engineers, students being either ambitious and capable artisans or practically-trained graduates of other technical high schools. In Germany, developments have taken place in the desulphurisation of charges carrying high-sulphur fuel or scrap, in the hot-blast cupola, and in the production from the cupola of special irons having high tensile strength or high resistance to shock, the latter being produced in the hot mould. While these developments frequently spring from the industrial side and appear to have little obvious connection with the provision made for scientific education and research, there is evidence to show that such a connection does definitely exist, and on this assumption the French school is being developed. Great Britain can show nothing comparable with the great Iron Research Institute at Dusseldorf, which the industry finds means to support, even in the present crippled condition of trade, or with the specialised work being carried on at the great Technical High Schools at Aachen and elsewhere.

The present time, therefore, seems opportune for the promotion of a general discussion on cast iron and modern foundry practice. Foundrymen unceasingly discuss among themselves the relationship between the engineer and the founder, and technical or metallurgical points on which both parties should be agreed, but opportunities such as the present, of inviting the comments of engineers, seldom arise. Both as designer of the casting and as its user the engineer is peculiarly closely related to the founder, and both are greatly concerned with improvements in quality, economies in production, and in weight reduction of the finished product.

Metallurgically, cast iron is the most complex alloy in ordinary use. It has never been regarded with very great favour by engineers, as it has suffered from the assumption that the product of a shaft furnace must necessarily show incalculable variations. The chief drawbacks to the use of cast iron from the engineers' point of view are, first, low specific properties, such as tensile strength, and more particularly elongation, and, secondly, lack of homogeneity, due to variations in the raw material and in the conditions of melting and cooling. This heterogeneity is undoubtedly the more serious cause of the engineers' distrust, as the designer can overcome difficulties that are merely due to low specific properties if these are reasonably uniform.

The cardinal advantage of cast iron, namely, its cheapness, has, indeed, in some respects been a handicap to its further development, for the price of the cheapest irons has tended to set a standard by which the price of high-quality engineering castings may unconsciously be judged. Indeed, the commonest objection among founders to the improvement of cast iron is that engineers will not pay for improved results, a view which can scarcely be maintained for long. Nevertheless, many of the difficulties of introducing high-quality irons for engineering purposes are due to the inadequate distinction made between cheap castings on the one hand, and on the other hand those highly specialised engineering castings the founding of which involves a considerable degree of technical control, careful selection of raw material, and considerable experimental work.

It is universally agreed that in engineering works continuous co-operation should exist between the foundry and the drawing and design office. Comparatively few works, however, have systematic means whereby this may be regularly ensured, and judging from the experience of the Cast-Iron Research Association in examining defects in castings, in no direction can so much improvement and economy be obtained. In one works the chief designer is head of both drawing office and foundry, with admirable results. In some large works there is a liaison officer between the two sides, who is of sufficiently good technical standing to be able to state his case adequately to both parties. Considerable success has also attended cases in which the foundry manager is an engineer capable personally of examining and checking designs, and even of assisting in the design in the initial stages. Any scheme of production, however, will be dependent at some point or other upon a close working understanding with the foundryman, whether he be foreman or manager, who is actually directly responsible for the production of the castings themselves. Normally, successful casting production calls for constant co-operation between men of widely differing types of training and experience, the engineering designer, the foundry manager or foreman, and the metallurgist or foundry engineer, and the co-operation required is of a much more intimate character than is necessary with other engineering products. In the case of cast iron, it may prove impossible to cast without modification a design that appears quite suitable from the point of view of disposition of material to meet the stresses involved. Satisfactory castings may be completely prejudiced by unsatisfactory test bars; good cupola control may be rendered useless by bad moulding practice, and skilled moulding may give poor results through rule-of-thumb methods of mixing and melting.

The Output of Grey Iron.

The characteristic of early engineering works was the foundry, as is indicated by the names they bore, but it was inevitable that some degree of specialisation should take place within the industry, resulting in the growth of jobbing and specialised foundries working for the trade as a whole and independent of any particular engineering works. The independent foundries, however, while large in number, are, on the whole, small in size, and do not dominate the industry. Consequently an industry comprising jobbing and specialised iron foundries, iron foundries attached to engineering works, steel and blast-furnace plants, and malleable plants, some of which again are connected with grey-iron foundries, necessarily appears amorphous in character, lacking that

* A Paper read before the Institution of Mechanical Engineers.

clear definition in financial control and scope which makes the organisation of an industry a relatively simple matter.

The total number of cast-iron foundries in Great Britain is approximately 2,800, together with some 300 steel foundries and 170 malleable iron foundries. The lack of form to which reference has been made has not in the past been favourable to the promotion of organised industrial research. Under present conditions the margin, apart from profit, required for experimental and development work scarcely exists. The traditional character of the industry and its present economic organisation, together with the depressed conditions which have affected iron founding with particular severity, are responsible in a measure for inability to undertake organised research on any considerable scale. As far as research done by individual works is concerned, the jobbing and specialised foundries are rarely of sufficient magnitude to justify a research staff. Better conditions exist in the great steel and engineering works, where facilities for experimental work exist, but here the foundry is one department of many, and often fails to secure more than a small share of attention. It should also be noted that the industry is very widely distributed geographically, and this again is a factor which prevents specialisation in its particular problems at a local university or a technical institution in the way, for example, that the steel industry has engendered a Research School at Sheffield.

The formlessness of the industry is well-illustrated by the lack of statistical information, as in virtually no form of statistical return is founding treated as an independent industry. Figures, for instance, are not available of the output of malleable or of grey iron, or of exports and imports of these materials, so that it is not possible to say definitely whether the use of grey iron is increasing or decreasing. Pig-iron is very well treated statistically in the returns of the National Federation of Iron and Steel Manufacturers, but only since 1915 has the production of foundry pig been reported separately from that of forge pig. From such information as is available it would appear that the use of grey iron, while slightly increasing, is not increasing at a rate comparable with that of pig-iron as a whole. The increase in pig-iron output has gone wholly into steel production.

Figures for the United States are rather more detailed, and these, given in Table I, indicate the same conclusion; that is, while the output of foundry iron is slightly increasing, it does not compare with the increase recorded for pig-iron. On the other hand, malleable iron and steel castings in that country show great increases, roughly comparable with and greater than those of pig-iron.

TABLE I.—*United States.*

(Figures represent millions of tons.)

	1903.	1913.	1923.
Pig-iron production	18.0	31.0	40.4
Foundry iron production	4.4	5.08	5.78
Foundry iron as a percentage of pig-iron	24.4	16.4	14.3
Malleable-iron castings	0.47	0.99	1.47
Malleable iron as a percentage of pig-iron	2.6	3.2	3.6
Steel castings	0.43	1.02	1.46
Steel castings as a percentage of pig-iron	2.4	3.3	3.6

With regard to British malleable iron the position is, of course, worse still. The industry is in a seriously crippled condition, and feels with particular acuteness the competition of other materials and alternative processes. The average production in the whiteheart malleable industry is very small, and technical control is more rare in malleable than in grey-iron manufacture. In this connection the lesson afforded by the experience of malleable producers in the United States should be instructive, the growth of that industry having followed combination among manufacturers, and the adoption of systematic research and production to standard specifications.

It is impossible to avoid the conclusion that during a period of remarkable engineering development in the mechanical, electrical, marine, automobile and aeronautical fields, all of which have created a demand for cast iron, the total output has been virtually stationary. If the material is to be exploited as fully as its inherent properties and its cheapness permit, the current metallurgical interest in cast iron is long overdue, and the next twenty years should see current and forthcoming improvements reflected in statistics.

Scientific research is only one of many factors which govern successful production, and it is not suggested that scientific research of itself, or even its successful application, will promote a steady growth in the industry. It must, however, be admitted that such an alloy system requires the same intensive study as has been applied, for example, to steel at Sheffield or to blackheart malleable in the United States, and that the comparative ease with which cast iron of a kind may be produced in the foundry should no longer be allowed to disguise its complexity.

Character of Research on Cast Iron.

Neglect of research on cast iron in the past has not been due merely to the conservatism of the industry, nor even to the difficulty of controlling the pig-iron from which castings are made. Some at least of the difficulty is attributable to the peculiar necessity in dealing with cast iron for co-operation between the practical man and the technical man.

Cast iron is essentially a material produced in bulk. It is uneconomical to produce it in small quantities from the cupola. Yet, if it is produced in any other way it ceases to be cast iron. Consequently research work on cast iron must be carried out on materials mixed in the cupola in the ordinary way, and cast into properly-made moulds. The laboratory research worker outside the industry who desires to study cast iron seldom has access to the equipment and skilled labour required for this, and many otherwise promising investigations have given results of limited value because experimental test-bars and castings have been produced either without the proper equipment or without skilled labour. On the other hand, it is impossible to convert the foundry into a laboratory. Experimental work must be done by a special staff, and the duties of those who are directly concerned with production work must be interfered with as little as possible.

Research on cast iron must therefore comprehend the scientists' metallurgical knowledge and the founders' intimate knowledge of practical conditions. It is agreed that in craft skill and practical experience British founders are unrivalled, but it generally happens that the men responsible for output in the foundry have little systematic technical knowledge or training. It is also unfortunately true that many men who have obtained scientific training in one of the now numerous metallurgical schools in various parts of the country have not been able or willing to equip themselves for more responsible posts on foundry practice by acquiring practical experience of all sides of foundry work. The result is that each type tends to lack that knowledge of the work of the other which would give greater understanding and sympathy, which in the case of cast-iron production for engineering work is imperative.

In some engineering works where it is recognised that technical assistance is essential in the foundry as well as in analytical and testing operations in the laboratory, attempts are being made to develop a type of man—much more common at the present time on the Continent than in this country—who has received metallurgical training with a considerable engineering bias, and who has had first-hand experience of all sides of foundry practice. Such a man is able to relieve the foreman of all work arising in connection with technical details relating to raw material, fuel, mixtures, melting practice, sands, and so on.

The foundry engineer forms an admirable means whereby the necessary liaison between foundry and design office referred to above may be exercised, and in so doing he bridges the gap, psychological even more than physical, which so often exists between these two sides of the works, and which causes the engineer and the founder to

think in mental-tight compartments. The ideal foundry engineer is able to regard the foundry as a production unit and to recognise fully that even the important scientific and technical sides are, after all, subsidiary to the economic side, and that questions of delivery and cost are just as important as those of quality.

Co-operative Research.

Both the character of the industry and the necessity for co-operation between the practical and technical sides render iron founding peculiarly suited for co-operative research, and a considerable advance in meeting research requirements has been made in the formation of the British Cast Iron Research Association, which has a comprehensive research programme relating both to cast iron and auxiliary materials, and to its methods of production. It forms a liaison body between the industry on the one hand and the metallurgists associated with the universities and national laboratories on the other. It keeps in touch with all experimental work and developments outside its own organisation, and, where desirable, and under certain conditions, assists research investigators and places the resources of the industry at their disposal. It endeavours particularly to ensure that developments are put into practice in the industry, and discusses freely with members foundry problems bearing on investigations in hand. While it does some work in its own small laboratory, the bulk of the investigations are conducted partly in university and national laboratories, and partly in the works of members, in every necessary case the required co-operation between a foundry and a laboratory being arranged.

A considerable amount of purely laboratory work, of course, has to be done on cast iron, such as determinations of fundamental physical constants, specific gravity in the fluid and solid states, specific heat, latent heat, thermal expansion and thermal conductivity of the various constituents in order that light may be shed on the behaviour of the aggregate. From the laboratory point of view, also, cast iron may be studied as a synthetic aggregate, the influence of each element in the mixture being determined in turn until a knowledge of the whole system is gradually built up. Work of this character is admirably illustrated by that being conducted at the National Physical Laboratory on behalf of the Ferrous Alloys Research Committee, which, however, deals exclusively with the carbon-free alloys. In order that the influence of carbon may be taken into account, the N.P.L. is also studying for the Cast Iron Research Association the equilibria of iron alloys in the presence of carbon in the proportions usually associated with cast iron. The iron-carbon-silicon system is now in progress, to be followed by the iron-carbon-manganese and iron-carbon-phosphorus systems. Such fundamental work is costly and slow, and more rapid tentative conclusions may be arrived at from the more empirical method of studying commercial cast irons with a view to correlating their mechanical, chemical, and microscopical properties. With the aid of practical experience and sound judgment this method can be used with success to secure the first approximations to conclusions which fundamental research will ultimately reveal fully.

Of what may be termed fundamental work, in addition to the work referred to above being conducted at the National Physical Laboratory, which will provide data of the first importance in the metallurgical study of cast iron, work is also being conducted by the Association's investigator at the University of Manchester on the influence of the various elements in cast iron on graphite formation, the size and distribution of graphite being of primary importance in dealing with the strength of cast iron.

The remaining investigations are of a more practical order, aiming at yielding information of more immediate use and value to the founder, but nevertheless requiring scientific method and skilled control. Investigations are being made into a series of castings from British irons, and a complete range of mechanical, microscopic, and chemical tests are being correlated, this work being conducted at the University of Sheffield, and in the laboratory of the Association. Also at Sheffield an important series of investigations on moulding sands is in progress for the Association, this being the only experimental work in the country at the present time on iron moulding sands. Complete strength, permeability, and other physical tests, in addition to chemical analyses, are being made on selected natural British moulding sands from the Bunter deposits, with a view to determining the properties of these sands and to correlating differences in behaviour with differences in constitution. Following these tests, the whole question of synthetic preparation of moulding sands and the renewal of used sands will be investigated. The Association is particularly interested in cast irons for special applications, the service conditions of which demand resistance to heat, to corrosion, or to abrasive wear. The last mentioned is a particularly baffling problem, the discussion of which would be valuable. In malleable iron several investigations are taking place, including the influence of total carbon on properties, methods of casting and treatment, and alloy additions.

Another very important field under review is that of melting practice, very little having been done in the standardisation of the cupola furnace and in the study of cupola melting.

Standard Specifications.

Enough has perhaps been said to show that the iron-founding industry is embarking none too soon upon systematic studies of its raw materials, methods and products with a view to their improvement, and to the more general production of uniform good quality irons for engineering purposes.

In order, however, that engineers may be able to rely on uniform material, it is necessary that it should be purchased to specification. In the last few years several B.E.S.A. specifications have been prepared for special irons, but no general specification has yet been produced. The difficulties in the way have been so many that they can only be referred to in passing. There is an inevitable variation in the pig-iron available to the founder, which has tended to prevent him assuming too much responsibility for the product. The influence of varying rates of cooling on the strength of cast iron renders the strength of a test-bar dependent upon the method of casting, such as whether it is cast on or off the casting it is intended to represent. It is influenced by its own dimensions, by the method and rate of pouring, by the method of moulding, by the proximity of the main casting, and by accidental or deliberate heat treatment. Then there is considerable room for argument as to whether the usual tests for cast iron are the best suited to the material and what alternative tests are to be preferred. The desirability of purchasing to specification, however, has led to the introduction of many specifications by the larger consumers. Consequently the British Engineering Standards Association recently formed a main committee for cast iron, and specifications are being prepared for ordinary grades of both grey iron and malleable iron, with standardised test-bars and methods of testing procedure. These specifications will, of course, be properly correlated with each other and with existing standard specifications for grey and malleable iron. When issued, they will not only form a means whereby engineers may rely on uniform products, but a basis on which gradual improvements in quality may be made as developments take place in the industry.

These, and many other indications, show that a new consciousness exists in the iron-founding industry, and that engineers may expect to see very considerable improvements in the next few years.

Conclusion.

The metallurgical characteristics of cast iron are beginning to be understood in such a way as to bring the complete scientific control of its production within the range of practical politics, and this is paving the way for considerable developments in the industry. These appear to lie along the following lines:—The introduction of special irons for particular purposes, having such qualities as will win for them either new fields of application or by virtue of their cheapness, fields now dominated by other materials; the development of specialised foundries concentrating on particular

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qualities of iron; improvements in moulding materials and melting practice leading to greater certainty and economy in production; the continuous application of research for the purpose of revealing more regarding the inner structure and properties of cast iron and the manner in which the information so revealed may be applied in practice.

The iron-founding industry is taking steps to make engineers much more satisfied with both the specific properties and general homogeneity and uniformity of cast iron by the establishment of national specifications and standards. As designers, as users, as foundry owners, engineers have it enormously in their power to facilitate these steps, and their ready acceptance of the experimental method in engineering development should enable them to do this without difficulty.

Great Britain is favoured in possessing the greatest resources in skilled men and managers. The country lacks opportunities for the installation of labour-saving equipment on a large scale as is common in the United States, and is far behind Germany in painstaking technical investigation. There is danger that this country in a basic industrial process may have to pay tribute to America and Germany for developments in the processes they have made their own, unless the industry can ensure permanent provision for similar work in this country. There is every reason to believe that, with such provision, in iron founding Great Britain could take the lead by virtue of a close combination of theory and practice.

British and Foreign Research Methods.

An address on "Impressions on American Manufacturing Methods and their Future Development," was given on Monday, by Mr. J. E. Fletcher, at a lunch arranged by the Dudley Chamber of Commerce. The guests included a large number of employers interested in iron and steel manufacture.

MR. FLETCHER (who is associated with the Department of Industrial Research) said his visit to America followed one to France, Belgium and Germany, and was the outcome of a desire to make comparisons of methods obtaining in those countries. On the Continent he went through iron and steel works and was particularly interested in the wonderful laboratories they had there. The French showed him a great deal, but their researches left one somewhat cold. The practical application of research there was not what one would have expected, especially now they were in possession of those great orefields.

In Belgium he found very much the same thing, but there was a step forward so far as concerned the practical application of research. They were certainly going ahead in the higher realms as well as practically applying the results of research activities.

In Germany, too, there were not only remarkable methods of systematic research, but practical application of them in works practice day by day. But so far as his German visit was concerned he saw no reason for us to be ashamed of our physical laboratories, or the men working therein.

In Germany they had evolved two or three processes of cast-iron production almost revolutionary in their character. They had succeeded in making cast irons which were equal to tests never known before.

During his visit to America (Mr. Fletcher continued) he looked for similar developments. He found, however, that research went only so far as it was utilitarian in the great mass-production establishments. It went only so far as they desired at the moment, and stopped just at the point where we in England would go on, and did go on. The men in the laboratories there stood as high as any in the world, but were not getting the support one would expect.

To Blacken Iron or Steel.—To give polished articles of iron or steel a deep lustrous black colour immerse them in a well-heated mixture of 1 part of black oxide of manganese and 10 parts of saltpetre (by weight). This mixture is best heated in an iron kettle until it is just sufficiently hot to char a pine stick. Extreme care must be taken to make the articles to be treated scrupulously clean before immersing in the mixture. All rough edges must be taken off and the whole surfaces made perfectly smooth. The general finish depends on this to no small degree. It is hardly advisable to treat articles of hardened iron or steel under this process, as their temper will undoubtedly be drawn.

The Scrap Problem in Germany.

The supply of scrap has for years been a bone of contention between consumers and merchants in Germany, partly because the latter have constantly carried on an agitation for the abolition of the embargo on the exports of this material. As representing the views of consumers, a communication has just been published in a German paper, stating that the experience gained during and since the war has shown that the amount of iron and steel scrap available in Germany is too small and that therefore exports must be prevented, at least unless German consumers can be assured that foreign markets are also open to them.

It is admitted that the demand for months past has fallen off, thus giving the impression that supplies are sufficiently ample to justify the lifting of the embargo on exports. But, from the consumers' point of view, such a step would be a short-sighted policy. No doubt merchants and steel-makers in common wish for the unprofitable steel situation generally to be ended. With a growing demand, stocks of scrap would prove insufficient and bring about a fresh rise in prices. Moreover, it is an established fact that, despite the further apparent reduction in the German steel production, the demand for scrap has again become more brisk, although it is admitted that there has been no scarcity of scrap in recent months.

The most important sources of scrap for the Westphalian industry in pre-war days and during the war were the large modern basic-Bessemer works in the Saar district, Lorraine and Luxemburg, which supplied the most suitable sorts, such as heavy rolling-mill scrap. These sources failed when France put an embargo on scrap exports in 1922, which continues in full force against Germany, but export permits are readily granted to Italy, Belgium and Great Britain. Germany would not only expose a weak point in connection with the negotiations for a treaty of commerce by an abolition of her export veto, but would also further strengthen French competition if she were to sell cheap scrap to France.

The conditions in respect of Czecho-Slovakia are similar. In this case there is no export veto, but her prices of scrap are higher than the German prices, so that scrap exports to Germany do not come into consideration at all. The works in Czecho-Slovakia, however, are flooding the German market with iron and steel products at prices which place the German works into a difficult position. In this case also Germany would run the risk of unfair competition if she were to supply the Czecho-Slovak works with cheap scrap.

Under such circumstances the scrap-consuming industry is urging the Government to continue the embargo, with this proviso, namely, that in the present state of depression there may arise cases in which export permits must be given for other economic reasons.

Finally, as regards so-called "concealed" exports, when the reasons formerly urged for the abolition of the export veto lost their force, some scrap merchants circulated the report that foreign firms were buying up scrap in Germany for the purpose of re-sale to Germany at high profits after the lapse of, say, six months or a year. There is nothing new in this practice, and it can be carried on by foreign speculators in spite of the existing veto on the export of scrap. Even an abolition of the embargo would not be able to prevent these speculators from buying up scrap in Germany and storing it for some time until a rise in prices, and thus enable them to gain large profits. But as a matter of fact, notwithstanding numerous inquiries among scrap merchants, it has not yet been possible to establish for certain that large purchases of scrap have been made by foreigners. What little information has been gathered from merchants on the subject is rather hazy, lacking in detail, and therefore cannot be taken seriously. The scrap merchants are anxious to obtain the abolition of the veto for purely speculative considerations. Steel-makers, on the other hand, are of opinion that more speculation in the scrap market, which would be fostered by the withdrawal of the veto, would further prejudice the chances of the German industry in foreign markets.

On the Relation of the Constitution of Grey Iron to its Engineering Properties.

By J. W. BOLTON, The Niles Tool Works, Hamilton, Ohio.

(*Continued from page* 509.)

Brinell Test.

In grey iron the Brinell number is a fairly good indicator of the tensile and transverse strength, the crushing strength and machinability. However, its use must be tempered with discretion. In Fig. 10 the Brinell-tensile curve shows increase in tensile strength from 100 to about 220 Brinell. The table shows that some bars vary widely from the average. The heat-treated bar's curve is close to the sand-cast bar's curve in the upper ranges, but departs more widely from it in the lower ranges, largely due to differences in grain size.

The Brinell numbers of low to high strength sand-cast irons are about the same as those of low to high strength annealed carbon-steels—that is, from 100 to 200; 100 is the approximate Brinell number of ferrite, while the Brinell of pearlite is about 200. From this it is seen that Brinell on grey irons tends to follow the amount of combined carbon, rather than to indicate the degree of discontinuity caused by the graphite flakes. While the flakes afford weak lines of rupture for tensile and transverse stresses, they apparently have much less effect in lessening the resistance to indentation. Like many other non-coherent materials, graphite cannot be forced to smaller volume if rigidly supported on all sides. Thus the Brinell number of a grey iron may equal that of a steel several times as strong as the iron. Fig. 10 shows how slightly grain size affects Brinell number. This is particularly evident on examination of that portion of the curve from 100 to 150 Brinell. The heat-treated bars of low Brinell number have small grain size and considerable strength as compared to the sand-cast bars of coarse structure. The strength increases with combined carbon up to about 0.80 per cent. combined carbon. Somewhat beyond this point strength drops. The Brinell number increases directly with combined carbon, from 100 to 200, when from 0 to 0.80 per cent. combined carbon and from 200 to very high value for white irons. The indentation of the Brinell ball usually shows that the metal has been stressed close to fracture, as incipient cracks are often found at considerable distance from the indentation.

Fracture of Grey Iron.

In the ordinary ranges of temperature, metals usually show trans-crystalline fracture under moderately rapid loading. At high temperatures or under extremely slow loading, the fracture may become intergranular. While the mode of fracture in grey iron may be in the manner indicated above, the complexity of the metal structure is such that the exact mode may be obscured.

One thing is certain—that the fracture follows the graphite flakes. Fracture through the pearlite seems both transcrystalline and intergranular. A plausible explanation for this is that pearlitic grains are often bounded by graphite flakes, the fracture being indistinguishable from the flake. In general, the fracture from graphite flake to graphite flake chooses the shortest path. In the author's experience he never has been able to find any evidence of sulphur network, and the idea that fracture depends on sulphur network seems to be no more than a myth. Phosphorus network has been claimed a requisite for strength. The fracture is not very particular, for it breaks right through Steadite crystals. Fracture in grey iron is not continuous, and it is probable that the breaking stresses are transmitted in a series of jerks rather than as a smooth action along slip planes. This explains how, due to its discontinuity of structure, grey iron shows no tendency to "neck" in the tensile test and possesses slight malleability.

Conclusions.

Correlation of data on structure of grey iron to data on physical properties indicates numerous relationships. Grey iron is composed of four major structural components. There are pearlite, ferrite, graphite, and steadite. While the amounts of these components can be closely approximated from analysis, the sizes and distribution of their grain structures are best determined microscopically. Characteristic properties of these components are as follows:—

Graphite (weak, soft). Fracture follows along graphite flakes, yet these flakes offer considerable resistance to compression. The graphite first forms *in situ* from the cementitic areas. Grain growth may obscure the characteristic formations of the "primary" flakes. The flakes may occur in long dendritic formations (indicating lower carbons) in whorl or rosette formations (indicating ledeburite. Such flakes could be termed eutectic-graphite from this formation) or in coarse, broad plates (which indicates primary cementite, hence high carbon). Increasing quantities of graphite promotes lower strength. Where the grain-size is large this effect is most pronounced.* Hence total carbon has its greatest effect in heavy sections. Graphite flakes cause the "open grain" appearance of grey iron. This appearance can be modified by the machine finish. They also account for the absence of elasticity and (in part) for the low resistance to shock.

Pearlite (strong and moderately hard). All highest test irons are nearly or entirely pearlitic

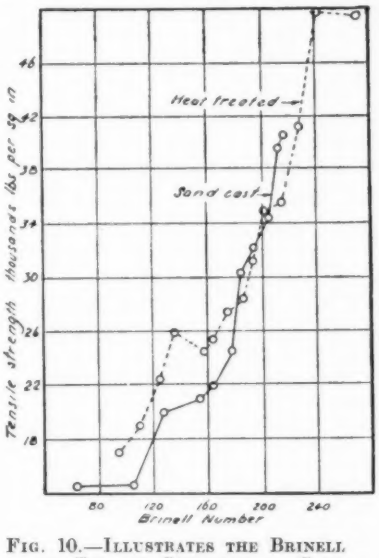

FIG. 10.—ILLUSTRATES THE BRINELL AND TENSILE STRENGTH OF SAND CAST AND HEAT-TREATED TEST BARS.

(or other transition forms), but the converse is not true. Brinell around 200 usually indicates a pearlitic matrix. If this is accompanied by low-carbon, high strength can be expected.

Ferrite (fair strength, softer and more ductile than pearlite). Sand castings of high ferrite are commonly very weak, as conditions which promote this formation also promote grain growth. Annealed ferritic castings may have fair strength if the small grain size is retained.

Steadite (brittle, abrasive). Strong irons can be made very readily without high-phosphorus. Due to its abrasive qualities, steadite reduces machinability. In some castings, notably sugar mill rolls and automobile cylinders, a certain amount of this hard component is claimed to have a beneficial influence. A microscopic study shows why phosphorus decreases deflection and resistance to shocks. In amounts varying from 0.20 to 0.90 per cent. phosphorus, the author sees very little difference in fluidity. Phosphorus seems to have some effect on the ease of decomposition of cementitic forms. It also influences the absorption of carbon.

It is highly desirable to know what iron will do in different sections. To have a specification test bar for every section is another matter. In theory it is fine, in practice not so good. For all ordinary work, bars 1.2-in. diameter serve well.

* From 30,000 to over 250,000 flakes per sq. in. were found in various samples examined by the author.

In castings of *uniformly* heavy section it is desirable to have a large bar because the smaller will chill. The large bar must be poured at an exact temperature and if 4-in. diameter will require a 50-ton machine to break it (12-in. supports). Most castings have sections of varying size. There the metal is determined by the smallest section. In very few castings the minimum section is under 2 in. Personally, the author would be satisfied with the present standard bar for all but very heavy castings. In this latter case he would also want to know the silicon and carbon.

Conclusion.

Correlation of knowledge of grey iron's constitution to knowledge of its engineering properties is a fundamental problem for the grey-iron metallurgist. The present Paper outlines the underlying principles governing such correlation, basing various conclusions upon experimental work conducted by the author. The problem is a complex one, but in this Paper it is simplified as far as is consistent with practical accuracy.

The properties of the metal depend upon its structure. In case of grey iron, the condition of the carbon is the determining factor. Once possessing sufficient knowledge of fundamental principles, it is possible for the metallurgist to predict the properties of the casting from the properties of a standard bar (such as the A.S.T.M. bar). The use of several test bars is cumbersome, it does not always give the results desired, and (in the author's mind) its impracticability would hinder rather than promote further extension of scientific methods.

Developing a Pattern Organisation.—II.

By M. E. NICHOLLS.

When inaugurating a pattern organisation care must be taken to ensure sufficient patterns to furnish the required number of castings, and in this connection it is usually the case that, although for the most part one casting off each pattern is wanted for each unit, in certain instances two, four, or perhaps more are necessary. Again, even where the one casting per unit operates, it does not necessarily follow that a six months' supply is the same number in every instance, for the question of scrap has to be taken into account.

This does not affect the issue when loose patterns are employed, for additional orders can be placed; but it is an important matter in connection with plate patterns. The practice of some firms in crowding upon one plate a number of different patterns leads to embarrassing situations, and, although it is well to have as many patterns as possible upon one plate, due regard must be made to the requirement in respect to castings, so that, instead of the plate containing, say, five different patterns, there is a duplication in at least one instance, where an extra number of castings are required.

The identification of the pattern is an important matter, and so is the identification of the casting. Many firms have omitted this precaution in the past, and the result is that many patterns are in existence which can only be identified by one person intimately acquainted with the product, and, as a rule, that person is not available when the pattern is wanted. The same remark can be applied to the casting, and it is often the case that the storekeeper is under the impression that he has no stock of a certain casting, because he cannot identify it, whereas really he has quite a number in stock.

Each pattern, then, should be given a definite number, this being affixed to the pattern, in such a manner as to be reproduced on the casting. The procedure applies to loose patterns, and also to patterns affixed to a plate, whilst, in connection with the last-named, a number should be given to the plate. The number allotted to the plate need not be in relation to the numbers of the patterns affixed to the plate, as the following shows:—"Plate No. 1, containing patterns numbered 456, 1873 (2), 29761."

It has been mentioned that all patterns should be inspected upon arrival from the foundry, and also before being sent out to the foundry. It may now be well to emphasise the necessity for care in the packing of the patterns for despatch, for in this respect some firms are very remiss. A pattern represents an item of considerable expense, and it should be taken care of; yet it is no uncommon matter for patterns to be sent off without being in the slightest degree protected, and to be returned from the foundry in a similar state. This happens more frequently when conveyance is by road, and not very long ago a lorry-load of loose castings were received by one firm, and underneath the heap were three or four expensive plate patterns.

Every firm should insist upon the utmost care being taken in packing and despatching, and should embody in the delivery note a clause to the effect that the pattern left the works well packed, and in first-class condition. If, upon the arrival of the pattern at the foundry, it is found that the statement is incorrect, the founder should at once notify his customer. The return of the pattern from the foundry, too, should be handled in a similar manner, and the customer should insist upon the foundry taking every reasonable care of the pattern while in the founder's possession.

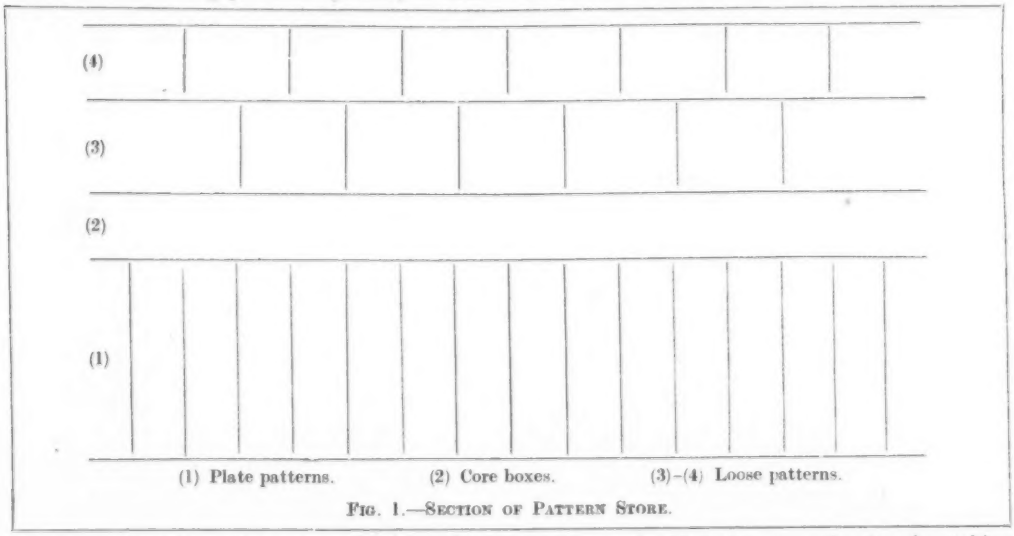

FIG. 1.—SECTION OF PATTERN STORE.

Assuming that the general principles given in this article are agreed to, there is no reason why an efficient pattern organisation cannot be developed. Taking one pattern for the purposes of illustration, we will show the procedure for handling it in all stages which, if adhered to, will give the best possible results.

The newly-completed pattern leaves the pattern shop, and is handed over to a competent inspector, who carefully checks it to the blue print, and if O.K. passes it to the pattern store, accompanied

by an acceptance ticket. This ticket gives particulars of the pattern number; order number on which it was made; numbers of core boxes and loose pieces; whether made of wood or of metal; whether loose or on a plate (if the latter, the plate number is given), etc. It will be seen from this that the pattern storekeeper has the fullest information, and it is his duty to make out a pattern record card, enter upon it this information, place the pattern in a bin, and enter the bin number upon the record.

The record cards are filed under the pattern numbers, in consecutive order, there being one card for each pattern, with an extra one in the case of a plate pattern. Thus there is a card for pattern number 1418, but if this is affixed to a plate (say, Plate No. 15), the card is endorsed "See Plate No. 15," and it is upon the card bearing this number that particulars regarding the whereabouts of Pattern No. 1418 will be entered.

When the pattern is to be sent to the foundry the pattern storekeeper receives a delivery note (in duplicate). Reference to the record locates the whereabouts of the pattern, which is taken from store, submitted to inspection, and passed over for packing and despatch. One copy of the delivery note is retained in the pattern store, while the other accompanies the pattern to the despatch department. When the pattern has actually been despatched, and the signature of the carrier appended to the delivery note, this note is returned to the pattern store, and an entry is made upon the record card, the number of the delivery note, date of despatch, and the name of the foundry being entered. The signed delivery note is then filed in the pattern store, while the other copy (which had been retained in the store) is sent to the buying office.

When in due course the pattern is received back from the foundry, the fact is recorded on a goods-received form, a copy of which is sent to the pattern storekeeper, who, upon receipt, makes the necessary entry upon the record card. The goods-received form is then sent to the pattern inspector, who at the earliest possible moment examines the pattern, and issues a report, this stating whether the pattern is O.K., or whether it has to be sent to the pattern shop for repair. One copy of this report is sent to the pattern store, and the other to the buying office. If the pattern is O.K., the storekeeper places it in the bin allotted to it, and the record is regarded as complete until instructions are received for the pattern to be sent out again to the foundry, when the routine just described is repeated.

If, however, the inspector's report states that the pattern has to go to the pattern shop for overhaul or repair, the buyer sends his copy of the report to the pattern shop, while at the same time the storekeeper enters upon the record the fact that the pattern has been sent for repair. In due course the pattern is repaired and pronounced O.K. by the inspector, and is again received in the store. The record is adjusted accordingly, and the pattern is placed in the bin.

INSPECTOR'S REPORT No. _____

Date _____ Pattern No. _____

Received from _____

DETAILED REPORT.

Pattern sent to _____

Signed _____

Inspector.

FIG. 2.—INSPECTOR'S REPORT.

There is nothing intricate in a routine such as the one just described, and, as every job worth doing is worth doing well, the handling of patterns should be thorough, so as to be really effective. It may be that storage accommodation is limited, but facilities can be provided to make the best use of that accommodation, while, so long as the precise whereabouts of the pattern appear upon the record, it does not matter in what part of the store the pattern may be. No matter how small the store, sectionising is always possible, and there is no excuse for any firm adopting the policy of heaping patterns upon the floor, to be sorted out when actually required.

The record is of vital importance, and the despatch of the pattern need not be delayed because the movement has to be recorded. There is more likelihood of delay at a later date, if the job is not done thoroughly at the beginning, and a routine, the working of which does not cause delay, but actually obviates it, cannot in any circumstances be stigmatised as "red tape"—a favourite expression of many mechanically minded works managers.

PATTERN RECORD.

Location _____ Pattern No. _____

Wood or Metal _____ Core Boxes _____ Loose Pieces _____

Made on Order No. _____ Date Completed _____

In from			Out to		
Date.	Delivery Note No.	Foundry or Shop.	Date.	Delivery Note No.	Foundry or Shop.

FIG. 3.—RECORD CARD.

IT WAS STATED at the meeting of the South African Iron and Steel Corporation, Limited, held at Pretoria, that since the failure of oversea negotiations to raise capital to develop the Pretoria iron deposits, other negotiations had been begun, but had lately taken an unfavourable turn. The directors, it was stated, viewed the future with grave concern.

Institute of British Foundrymen.

ANNUAL DINNER OF THE LONDON BRANCH.

The annual dinner of the London Branch of the Institute of British Foundrymen was held at the Engineers' Club, Coventry Street, Piccadilly, W.1, last Friday. Mr. Geo. C. Pierce (the Branch-President) presided over a large gathering of members and visitors, which included Mr. John Cameron, J.P. (President of the Institute), Mr. W. B. Lake (Vice-President), Mr. K. W. Bridges (Secretary of the Foundry Trades Equipment Association, and an organiser of the forthcoming Foundry Trades Exhibition), Mr. F. W. Watson (of the Chemical, Metallurgical and Mining Society of South Africa), Mr. H. J. Young (of Newcastle), Mr. V. C. Faulkner (Senior Vice-President of the Institute), Mr. R. J. Shaw (Vice-President of the London Branch), Dr. J. L. Haughton (Chairman of the London Local Section of the Institute of Metals), Mr. Wesley Lambert, Mr. A. R. Bartlett, Mr. H. O. Slater, and other well-known London foundrymen, as well as representatives of kindred institutions.

Forthcoming Foundry Exhibition.

The loyal toast having been duly honoured,

MR. K. W. BRIDGES proposed "The Institute of British Foundrymen." He was glad of the opportunity of doing so, he said, because he had one or two debts to pay to the Institute. He reminded the members that it had its beginning, as the British Foundrymen's Association, some 22 years ago, as the result of the efforts of some pioneer gentlemen in Birmingham; from that it had developed to what it was to-day, an Institute numbering amongst its members representatives of all sections of the trade, from managing directors to the working foundrymen. There were about 1,600 members. In 1922, during the Presidency of Mr. Oliver Stubbs, it had been incorporated as an Institute by Royal Charter. Also, from the beginning the Institute had pursued the very wise policy of decentralisation, in that it had branches all over the country, which was so extraordinarily important in a body of this kind. Some of the bodies with which he had had some connection were too much centralised, and too much controlled from London, with the result that the districts in the provinces felt that they were rather neglected. That could never be said of the Institute of British Foundrymen, however. The Institute had also, to its credit, the closest association with its kindred bodies in this country and overseas—in the Dominions, in America, France and other foreign countries, and, now that the Locarno Pact was signed, perhaps also in Germany. The record of the Institute was one of which its members might well be proud. He himself was proud of his connection with the Institute, and particularly the most recent one, which arose with regard to the exhibition which his firm would be organising next year. He believed he might very safely say that, had it not been for the support—the almost anticipatory support—of the Institute, his firm would never have undertaken the organisation of that exhibition. It was because the Institute had extended its patronage to them that the organisers, and the Foundry Trades Equipment and Supplies Association—for which, to some extent, he spoke—as manufacturers and exhibitors at that exhibition, had seen fit to make arrangements for the second foundrymen's exhibition ever held in London. The first was held, he believed, under his father's management, in 1912. Speaking for the Equipment Association, he would say that so far they had two objects in view, though there might be other ramifications later on. The first was the control of foundry exhibitions, and the second was the very closest co-operation with the Institute. In connection with the latter, they had been most materially assisted by Mr. Faulkner and THE FOUNDRY TRADE JOURNAL, whom he wished publicly to thank for their assistance in bringing that co-operation into being. No doubt the members of the Institute were familiar with the programme, but he extended to them, in advance, the heartiest possible welcome on the day set aside for them to visit the exhibition. The organisers hoped to entertain a large number of the Council and special guests to luncheon, and the whole of the membership of the Institute to tea. Finally, Mr. Bridges coupled with the toast the name of Mr. John Cameron, the President of the Institute. Everyone present would admit, he felt sure, that both in business and social life Mr. Cameron was an ideal President and friend.

International and Dominion Association.

MR. CAMERON, responding, said it was a very great pleasure to him to be present at this happy function. Those in Scotland, he said, had always looked to the London Branch as giving the Institute a lead, because there were opportunities in London which were not open to those in the North. Being a constant and keen student of everything that went on under the auspices of the Institute, he had sometimes envied the London Branch its opportunities and privileges. It had had the privilege of entertaining—and of entertaining right royally—the American foundrymen who had visited this country, and who, apparently, were so well treated in London that they had not time to go to Scotland. Again, the members of the Branch had had the opportunity quite recently of entertaining a very fine man from South Africa in the person of Mr. Moore. He looked upon that as an exceedingly great thought on the part of the London members, as showing how they appreciated him as a man, and how they appreciated his visit to this country. He (Mr. Cameron) had had the pleasure of meeting Mr. Moore's associate in business, namely, Mr. Hobbs. The members of the London Branch had the privilege of meeting such men, and of showing them a little hospitality and a little kindness. In the light of recent events, the Institute had amply justified its existence. He believed the industry to-day was on the eve of new developments. The last development of the kind had occurred about ten years ago—during the war. At that time founders had been called upon to produce castings for munition purposes of a quality which they had never produced before, and, on the whole, they had risen to the occasion well. To-day they found themselves in a similar position. The mechanical engineers, shipbuilders, etc., were calling for castings of a quality and strength, together with reduction of weight, which they had never called for before, and he believed the ironfounders were on the eve of being able to say that they could meet the conditions set forth by the engineers. A few years ago the limit of practicability had been reached in the use of cast iron for Diesel engine castings, but to-day there were developments which showed that the founders could go beyond that limit and could give the engineers metal which would be more useful to them in their work. Discussing the forthcoming Foundry Exhibition, he said he was one of those who firmly believed in such exhibitions. The first exhibition under the auspices of the Institute was held in Birmingham in 1922, and the members of the Council of the Institute at that time were pretty equally divided on the question of whether or not it should be countenanced or encouraged by the Institute. At present, however, we had come to a more enlightened frame of mind; the idea to hold the exhibition next year was an excellent one, and it would be a great asset to the Convention which would be held in London at the same time. He felt sure that the exhibition would be a success, if only for the reason that Mr. Bridges had undertaken the responsibility of organising it.

MR. W. B. LAKE then proposed the toast of "Kindred Associations." Visitors were always heartily welcomed to the annual dinners of the Branch, and none was more heartily welcomed than the representatives of kindred associations. The main object of the Institute of British

Foundrymen was to improve the efficiency of the foundries of this country and thereby raise the status of the industry and of the men engaged in it. The members of the kindred associations were also engaged in raising the status of the various industries with which they were connected, but, more than that, they were actively engaged in helping foundrymen in their work. Foundrymen owed a great debt of gratitude to those associations for the assistance they had rendered in the past. The members of the London Branch were fortunate in having amongst them that evening representatives of the Institute of Metals, the Iron and Steel Institute, the Chemical, Metallurgical and Mining Society of South Africa, and the Institution of Engineering Inspection, all of whom were very heartily welcomed. He coupled with the toast the name of Mr. F. W. Watson (of the Chemical, Metallurgical and Mining Society of South Africa), who was doubly welcome; he was welcome, in the first place, as a member of a kindred association, and, in the second place, as a representative of the Dominions. (Applause.)

Work of Technical Societies in S. Africa.

MR. F. W. WATSON, B.Sc., F.I.C., responded, and, after expressing his thanks for the hospitality extended to him, referred to the formation and progress of scientific societies in South Africa, and in Johannesburg particularly. There had been a scheme afoot for many years for the joint housing of the societies there, and for a long time they had not got beyond talking about it, but about five years ago it had materialised. Premises were acquired, and a scientific and technical club formed, and scientific meetings and social functions were held there. They had been able to do that mainly by the generosity of the Transvaal Chamber of Mines, which represented all the mining groups in the country. The Chamber of Mines had granted them a very big loan, running into many thousands of pounds, and had very generously foregone interest on that sum. The work of the associated societies was most important to the life of Johannesburg. For instance, at the beginning of 1922 there had been a very big strike, and it turned out to be something more than a strike. It had started in the coalfields at Whitbank and Middelburg, and spread to the Rand, and the whole of the gold mining industry was shut down. He was not sure that the people in Great Britain appreciated what that meant, but South Africa practically depended upon its gold mining industry. Not only was the gold mining industry affected, however, but the trams were stopped, and finally the strike spread to the power station. Certain of the coal, from Whitbank, was said to be "scab" coal, and the men would not use it; there was a certain amount of "clean" coal, which was used for a time, but soon the stock was exhausted. The associated societies considered that this was something more than an industrial dispute, and decided to run the power station themselves. In Johannesburg there was a small white population among a large body of natives—the ratio was about 8 to 1—and the town natives were worse than any; they seemed to pick up the vices of the white man, without any of his virtues. If the power station had been closed it would have meant a tremendous calamity. That power station was kept going by the associated societies. The mining industry of the Witwatersrand depended greatly upon the British foundry industry for acid-resisting metal, for heat-resisting metal, and, above all, for drill steel. In again expressing thanks, on behalf of himself and the representatives of other kindred associations, for the hospitality extended to them, he said he would acquaint the controlling Executive of the associated societies in Johannesburg of the excellent work which the British foundry industry was doing.

The Foundryman and the Metallurgist.

MR. H. J. YOUNG, F.I.C., proposing the toast of "The London Branch," recalled that Mr. Cameron had spoken of the London Branch as representing progress, and had stated that all other branches looked towards it. In this connection he said he had spent a very long time in Germany this year, in the course of four or five visits, and he could assure the members that if the London Branch were to represent progress it had something to do. During the year he had visited many foundries in the country, as well as other branches of the Institute, and he did not think that the foundryman—whom he admired amongst all tradesmen and all workers—must mend his ways and remember that we had reached the year 1925. The ironfoundryman of this country had been in the very difficult position of having to be a self-styled metallurgist as well as a foundryman, and had had to appear to the engineer as though he knew something about the metal. The foundryman had to spend a lifetime learning to be a foundryman; equally, the metallurgist had to spend a lifetime learning to be a metallurgist, and it was time, in his opinion, that the Institute remembered its motto—"Science hand in hand with Labour." He did not see that at its meetings. Instead of that, he had seen the scientist trying to do his little bit and to tell what he believed to be the truth, and the foundryman very often trying to put him under. He believed that the future of the ironfounding industry in this country depended upon putting a stop to that once and for all. We had to have fair play, but we did not always get it, and he was speaking straight from the shoulder when he said that he had not had fair play from some of the branches of the Institute, and from foundrymen in this country. British foundrymen had claimed to him to have done things they had not done, and that was unnecessary. The British foundryman was a very fine man, but he was not making himself finer by claiming knowledge which he did not possess. Mr. Young said he was taking this opportunity of making these remarks because he had been told that it was time he came out into the open, and he was out in the open now. With regard to the toast, he said that no one wished for the good health of the London Branch more than he did, because he hoped he would be admitted a member next year. He coupled with the toast the name of the Branch President, Mr. Geo. C. Pierce.

MR. GEO. C. PIERCE (Branch-President), responding, gave voice to the impressions he had formed when he had first been elected a member of the London Branch. Quite frankly, he had joined the Institute because he believed he was going to get value for his money, and he could assure everyone present that he had got it. The first thing that had impressed him was the geniality of those with whom he came into contact. He believed that at that time the activities of the branch were at a fairly low ebb, but, as the result of the efforts of Mr. Faulkner, Mr. Lambert, Mr. Sommerfield, Mr. Bartlett and other gentlemen, he himself could now claim to be the President of the most lively Branch of the Institute. Maybe it was not the strongest numerically, but it was going to be before very long, and it was going to do some very great work in the near future. He was sure the Branch could do it, but it needed all the endeavour and all the enthusiasm of every member to establish it firmly as *the* branch of the Institute of British Foundrymen. Next year, he believed, would be an epoch-making year for the Institute, but every member of the London Branch must give of his best—and he felt sure they were prepared to do that. Referring to Mr. Young's remarks, he assured him that there were members of the London Branch who were fully alive to all that was claimed for his particular metal, and who believed in it. He did not want Mr. Young to join the London Branch next year prepared to flay the members at the first opportunity; he wanted him to feel that he had some friends there who were with him all the way. Finally, Mr. Pierce thanked the gathering for the manner in which the toast had been received.

It was a happy thought which prompted Mr. H. G. Sommerfield (the Hon. Secretary of the London Branch) to propose a final toast to the men who grovelled in the sand all day and handled the molten metal from the cupola. The toast was not included in the official toast list, but he felt it was particularly appropriate at such an informal gathering.

The toast, To the "Sand Rat," was received with enthusiasm.

An excellent musical programme was rendered during the evening, under the direction of Mr. Arthur Ayres.

XUM

Trade Talk.

THE FIRM of Steel, Peech & Tozer, Limited, The Ickles, Sheffield, last week celebrated the jubilee of its establishment.

AN OUTBREAK OF FIRE was discovered on the premises of James Whitfield, Limited, brassfounders, Oxford Street, Birmingham, last week.

COX & DANKS, LIMITED, have now raised the German destroyer "B110" at Scapa Flow, which is the second of the 1,300-ton type to be salvaged, and makes the total 20 to date.

IN THE ELEVEN MONTHS of this year 48 vessels of 191,922 gross tons were launched from the Tyne, a decrease of 15 vessels and 58,122 tons on the corresponding period of last year.

THE ADJOURNED CONFERENCE between the Minister of Labour and representatives of the Engineering Employers' Federation and the engineering unions, on the question of foreign competition, was opened last Monday.

ORDERS FOR CASTINGS for two large cranes have been received by Blackett, Hutton & Company, Limited, Cleveland Steel Works, Guisborough. One is a floating crane to lift 150 tons, which is being constructed for the Port of London Authority.

THE BURNTISLAND SHIPBUILDING COMPANY, LIMITED, have received an order from North-East Coast owners for a cargo steamer of 4,000 tons deadweight. The propelling machinery, working on super-heated steam, will be supplied by the North-Eastern Marine Engineering Company, Limited, Wallsend-on-Tyne.

FORMING PART OF A SCHEME for the relief of unemployment, a new highway is now under construction at Bolton, in connection with which three steel bridges are required. One of the bridges is to carry the railway line across the road, and, to avoid blocking both the up and the down lines at once, is to be built in two halves. John Booth & Sons, Limited, Bolton, are carrying out the whole of the work.

SWAN, HUNTER & WIGHAM RICHARDSON, LIMITED, of Wallsend, have an order from the Ellerman Line for a new vessel. The engines will be supplied by the Wallsend Slipway & Engineering Company, Limited. The company have also an order for an oil tanker of about 10,000 tons for British Tankers, Limited, which along with the machinery, will be constructed at the Neptune Yard, Walker.

WE HAVE RECEIVED from W. Richards & Sons, Limited, of the Britannia Foundry, Middlesbrough, and the Dinsdale Moor Iron Works, Fighting Cocks, Darlington, a copy of the 6th annual issue of their chart of iron and steel prices, covering the years from 1914 to 1925 inclusive. Spaces for each month, up to November, 1926, have been left so that fluctuations may be recorded up to date if so desired. Printed in colours, the chart should prove most useful, an interesting feature being the indication by arrows of the period of duration of all the more important strikes in the 12 years covered.

THE COMPLETE STOPPAGE of blast-furnace operations by the Millom and Askam Hematite Iron Company, Limited, for fully three months, involving the closing down of the Florence Mine, combined with a heavy fall in the value of pig-iron, absorbed the major part of the profits made when trade, though far from good was nevertheless on a better level as regards both volume and realised prices. The current improvement in trade has enabled the company to blow in two furnaces and get the Florence Mine back to a larger production. An increased output, both at blast furnaces and mines, can be obtained when trade conditions justify. The development of the Florence Mine exceeds expectations. During the year the company acquired from the Coltness Iron Company, Limited, their holding in the Alquife Mines and Railway Company, Limited. These mines have been restarted.

SIR ARTHUR DORMAN, speaking recently at the annual meeting of Dorman, Long & Company, Limited, said that he had a feeling that we were nearing the end of the post-war depression, and when the time came, the British iron and steel trade, which had done so much to put its house in order, would be as well placed as any other trade in the world to reap the benefit in the turn of the tide. During the year the iron and steel trade applied for protection under the Safeguarding of Industries Act. They had not heard the result, but there were rumours that it was not going to meet with success, and it would appear, therefore, that they might have to go on fighting their battle unaided. But he believed they would win through, although trade might suffer severely before the struggle was over. Short of what the trade had asked, the best way the Government could assist was to devote its attention to those other occupations and industries which to-day kept up the cost of living, and which so largely swelled their cost of production. He referred to State, municipal, and private extravagance, and to the artificial standard and conditions of life in non-competitive trades and public services of the country.

Gazette.

MESSRS. J. S. JOLLIFFE and F. E. HOUGHTON, iron and brass founders, The Old Foundry, Lallous Yard, Cowes, Isle of Wight, trading under the style of J. S. Jolliffe & Company, have dissolved partnership.

MR. J. C. GOULD appeared for public examination at the London Bankruptcy Court on December 15. The debtor had filed accounts showing total liabilities of £1,140,326, of which £768,940 is unsecured, and no available assets. He attributed his insolvency mainly to the effects of trade depression upon the shipping, shipbuilding, and engineering trades and to heavy taxation, and industrial unrest, which resulted in the companies with which he was actively connected ceasing to make profits, whilst the shares held by him therein became valueless, but also to his liability under guarantees given by him on behalf of some of the said companies. The examination was adjourned.

Personal.

MR. J. C. BLAIR (A. G. Kidston & Company), Mr. R. Booth (Whitehead Iron and Steel Company, Limited), Mr. J. J. Goddard (Bowesfield Steel Company, Limited), Mr. Robt. Pooley (Shelton Iron and Steel Company, Limited), Mr. H. J. Skelton and Mr. J. H. Skelton (H. J. Skelton & Company, Limited), Mr. Watson Slack, and Mr. James Whitby (John Summers & Sons, Limited), have been elected to fill the eight places which became vacant on the committee of management of the London Iron and Steel Exchange. With the exception of Mr. R. Booth all those elected were retiring members of the committee.

Wills.

PEECH, H., of Ridgway, Wimbledon, of Steel, Peech & Tozer, Limited ...	£107,368
MILLINGTON, B. H., of Pendenes, Penn, Wolverhampton, hollow-ware manufacturer	£22,466
POWELL, R. J., of Llandudno, for many years associated with the firm of Powell Bros., engineers, Wrexham	£2,563

Company Meetings.

John I. Thornycroft & Company, Limited.—SIR JOHN E. THORNYCROFT indicated that the position was somewhat more satisfactory than in the previous year, at the annual meeting on December 9. The profit was £37,861. The shipbuilding and marine engineering side of the business had been adversely affected by the depressed conditions in the industry generally. Last year he said that it had only been possible to secure orders without a proper margin of profit, and that delay in delivery had occurred through labour disputes. While they had had better labour conditions, uncertainty had, necessarily, militated against a revival of the shipbuilding industry. He did not think it was generally realised what a heavy burden the company had to carry in taxation, and now they had to look forward to quite a considerable increase due to the cost of the new pensions scheme.

Bengal Iron Company, Limited.—The seventh annual meeting was held on December 11 in London, MR. W. T. MACLELLAN, who presided, said that the lay-out of their blast-furnace plant was not quite as modern as the one in which they had a 55 per cent. interest and which had a productive capacity of double their own, and they were taking advantage of the stoppage to make a number of improvements in their own plant. There were many blast-furnace plants in Britain which were not as up to date in their equipment as theirs was to-day. Their new foundries and machine shops were of the most modern construction, and had an output capacity of 60,000 to 70,000 tons annually, which few foundries anywhere had, and they had received a letter from an engineer who had visited their works in which he had expressed his high opinion of, as he had said, their excellent workshops. The Mining Institute of India had recently visited their new colliery plant at Jitpur, and had expressed the greatest satisfaction with it, as being about the finest plant in India. Sir John Collie, in the course of a lengthy statement, set out the complaints that the members of the late committee had against the directors. A lengthy discussion ensued, and subsequently the chairman announced that Mr. J. Angus, Mr. C. A. Bendix, Mr. H. FitzPatrick and Mr. Thompson Jowett had been re-elected to seats on the board.

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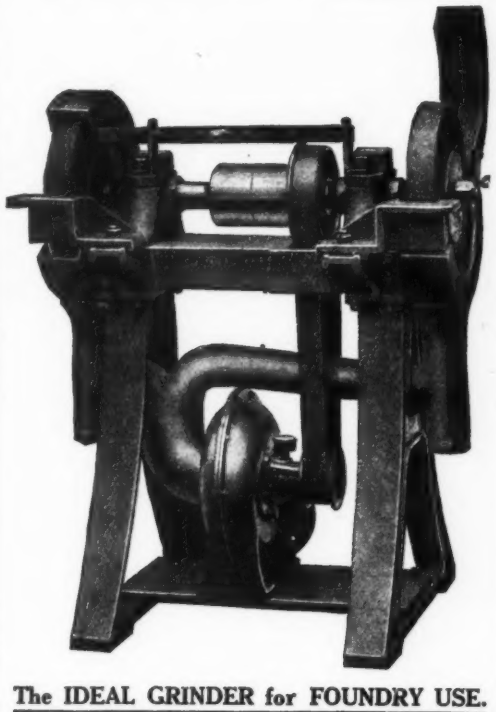

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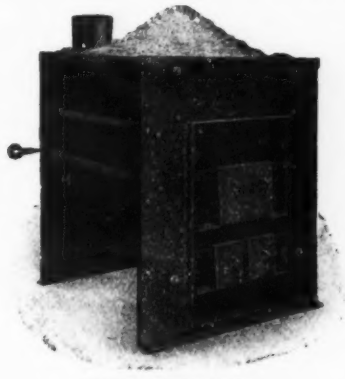

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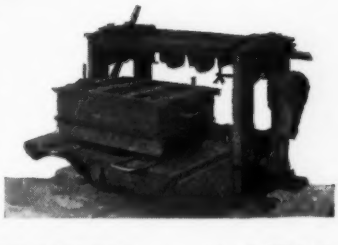

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IRON AND STEEL MARKETS.

Pig-Iron.

MIDDLESBROUGH.—Thanks to the recent revival of activity, the Cleveland iron markets are closing down for the Christmas holidays in a more cheerful mood than might otherwise have been anticipated, makers now expressing a confident hope that the opening of the New Year will witness a speedy resumption of something like normal conditions in the very near future. In the meantime business is progressing on quiet, steady lines, with buyers making universal holidays, and deliveries practically suspended during the intervening fortnight, and prices remaining without alteration, as follow:—Home: No. 1 foundry, 69s.; No. 3 Cleveland G.M.B., 66s. 6d.; No. 4 foundry, 65s. 6d.; No. 4 forge, 65s. per ton, all f.o.t. Export: No. 1 foundry, 69s. 6d.; No. 3 G.M.B., 67s.; No. 4 foundry, 66s.; No. 4 forge, 65s. 6d. per ton f.o.b.

In the Tees-side hematite market demand continues on a steadily expanding scale, necessitating the relighting of idle furnaces in some of the producing districts. In this connection also prices have undergone no change, but with a hardening tendency at 75s. 6d. per ton for East Coast mixed numbers, with West Coast qualities as follow:—Bessemer mixed numbers are quoted at £4 1s. 6d. c.i.f. Welsh ports, £4 5s. per ton delivered at Glasgow, £4 8s. 6d. per ton delivered at Sheffield, and £4 12s. 6d. per ton delivered at Birmingham.

LANCASHIRE.—The outlook in the local engineering industries having improved to some extent of late, the demand for foundry pig should shortly increase to a corresponding extent, but at the moment inquiries for the usual brands of Midland irons can only be termed moderate in volume. Prices may now be quoted 65s. at the furnaces for No. 3 Derbyshire and 62s. to 62s. 6d. for No. 3 Northants. Continental foundry iron is still uncompetitive, and none is coming into the Midlands. Neither is Lincolnshire foundry iron being sold locally on any scale.

THE MIDLANDS.—The general position in regard to foundry pig markets in this area has not differed from that obtaining when previously reported, except perhaps there is not quite the same demand for pig-iron as there has been for some weeks. Current quotations are as follow:—Derbyshire No. 3 foundry, 65s.; Staffordshire No. 3 foundry, 65s.; Northants. No. 3 foundry, 62s. 6d.

SCOTLAND.—The close of the year finds business in this Northern area still quiet and uneventful, work, however, being continued until the New Year, the Scottish holiday period. Demand for pig-iron remains slow, with prices indicating a slightly weaker tendency, the current quotation for No. 3 foundry quality remaining at 77s. 6d. at furnace.

Finished Iron.

The week's markets for all descriptions of manufactured material have been without signs of activity, the majority of buyers having already secured requirements for the remainder of the year, and consequently marking time for the present. Slightly more employment in the iron mills is reported, but it does not amount to sufficient to create hope of an extensive increase of demand. Nor can there possibly be such hope until the general level of prices is more competitive with those quoted by the foreigner and with steel. Of this there seems no prospect whatever, and it looks certain that the only demand enjoyed by the iron makers must continue to be for special qualities and purposes. The firms which can command this trade are not doing badly, although other prices are so low. The reduction in marked iron is reported so far not to have made much difference to demand, but probably this is due to the season of the year rather than to any other known cause. After the turn of the year more vigorous demand is anticipated. The iron strip trade is described as good, and the increase in demand for commoner iron resulting from the labour trouble on the Continent continues, but the use of steel for purposes to which this quality of iron used to be employed seems to have become firmly established, and there is very little if any hope of regaining the trade under present price conditions.

Steel.

According to reports from the chief centres of the industry, the outlook in the steel market shows promise of better times in store, which it is hoped may materialise in the New Year. Reference has been recently made to the apparent attempt to stop the continual fall in structural steel prices which has been reported of late and lift them again. So far it does not look as though the idea commands general support, as there are still producers who do not hesitate to cut to obtain business, and for the time being, at any rate, quotations may be left where they were. Of course, sellers are making the most of every chance to talk up the market. Attempts to enhance strip and small bar prices do not meet with any more success. Business in the tinplate market has been quiet of late with about 19s. 10½d. to 20s. 1½d. as the current figure for standard sizes, net cash, f.o.b. Bristol Channel ports.

Scrap.

In view of the holiday conditions now imminent, business in the scrap metal markets has been substantially reduced in volume, with prices for most qualities almost stationary at recent quotations. The demand for cast scrap in Lancashire is rather restricted, and the feeling seems to be a little weaker. Some dealers say that 70s. per ton is now the highest price they can get for lots of really good quality, although one does not hear that any "textile" scrap is to be had at the price. There was a time when this class of scrap used to sell to founders engaged on castings for the textile machinery trade at within 2s. 6d. per ton of the price of Scotch iron, and it does not seem altogether reasonable that there should now be a difference of about 20s. In the Scotch markets cast-iron borings are 47s. 6d. per ton. Machinery cast-iron scrap remains firm—that is, for pieces not exceeding 1 cwt.—at 73s. to 74s. 6d. per ton. Ordinary cast-iron scrap to the same specification is about 66s. 6d. per ton, and for steelworks' cast-iron in furnace sizes, 65s. per ton. Old cast-iron railway chairs are somewhat quiet, but the price remains fairly firm at 72s. 6d. to 73s. 6d. per ton. Light cast-iron and firebars is 56s. per ton, and re-rolling rails show no change at 65s. per ton. The above prices are all per ton, delivered f.o.t. consumer's works.

Metals.

Copper.—The easier tendency in base metal values continues so far unchecked in standard copper, and for the moment the outlook may be best described as obscure. During the past week fluctuations in a downward direction have again depreciated quotations considerably below the best of the year, as will be evidenced by the appended figures now current. Current quotations:—*Cash*: Thursday, £59 12s. 6d.; Friday, £60; Monday, £60 5s.; Tuesday, £60.

Three Months: Thursday, £60 15s.; Friday, £61; Monday, £61 5s.; Tuesday, £61 2s. 6d.

Tin.—Heavy realisations, due in a measure to financial stringency at the year's close, have also adversely affected the outlook for tin, and a sharp decline in values at mid-week brought the selling price down to £275 15s., a relapse of about £4. It is, of course, possible that the position has been momentarily affected by the disturbed conditions of the French exchange, but it is to be feared there are but slight hopes of recovery of strength until after the holidays are concluded. Current quotations:—*Cash*: Thursday, £280 15s.; Friday, £281 15s.; Monday, £286; Tuesday, £285 10s.

Three Months: Thursday, £276 15s.; Friday, £277 2s. 6d.; Monday, £279; Tuesday, £278 10s.

Spelter.—Conditions in this section of the market continue comparatively steady, with prices showing only a fractional decrease, readily explained by a decrease in demand owing to seasonal causes. Current quotations:—*Ordinary*: Thursday, £38 3s. 9d.; Friday, £38 10s.; Monday, £38 8s. 9d.; Tuesday, £38 6s. 3d.

Lead.—The market for soft foreign pig has certainly lost strength of late, and, compared with the conditions prevailing this time last year, when the quotation stood at nearly £45 per ton, with a prospective increase in consumptive demand in the New Year, there seems little reason to anticipate an immediate slump in the metal. Current quotations:—*Soft foreign (prompt)*: Thursday, £34 12s. 6d.; Friday, £34 15s.; Monday, £34 11s. 3d.; Tuesday, £34 5s.

EDWARD G. HERBERT, LIMITED, Atlas Works, Chapel Street, Levenshulme, Manchester, have now established a London sales office at 68, Victoria Street, Westminster, S.W.1. Mr. G. W. Risdon will represent the company in the Metropolitan area.

XMAS 1925

BEST RESPECTS

AN'

WISHIN' YER ALL YER WISH YERSELVES

THOMAS E. GRAY & CO., LTD.

The Makers of "SILACENE"

119, HIGH HOLBORN, LONDON, W.C.1

— ESTABLISHED 1877 —

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	60	0	0
Three months	61	2	6
Electrolytic	66	5	0
Tough	63	0	0
Best selected	64	0	0
Sheets	90	0	0
India	77	0	0
Wire bars	66	10	0
Do. Jan.	66	5	0
Do. Feb.	66	5	0
Ingot bars	66	5	0
H.C. wire rods	70	15	0
Off. av. cash, Nov. 61	6	10¼	
Do., 3 mths. Nov. 62	6	3	
Do., Sttlmnt, Nov. 61	6	5¼	
Do., Electro, Nov. 68	2	10⅝	
Do., B.S., Nov.	65	10	0
Aver. spot price copper, Nov.	61	6	5
Do., wire bars, Nov. 68	7	10¼	
Solid drawn tubes		13d.	
Brazed tubes		13d.	
Wire		10d.	

BRASS.

Solid drawn tubes	12d.
Brazed tubes	13½d.
Rods, drawn	11½d.
Rods, extd. or rlld.	7½d.
Sheets to 10 w.g	10½d.
Wire	10⅝d.
Rolled metal	9½d.
Yellow metal rods	7½d.
Do. 4 × 4 Squares	8d.
Do. 4 × 3 Sheets	8½d.

TIN.

	£	s.	d.
Standard cash	285	10	0
Three months	278	10	0
English	285	0	0
Bars	287	0	0
Straits	289	0	0
Australian	287	15	0
Eastern	283	0	0
Banca	294	0	0
Off. aver. cash, Nov.	284	14	1⅜
Do., 3 mths., Nov.	281	14	9⅜
Do., Sttlmt. Nov.	284	13	6⅜
Aver. spot., Nov.	284	13	7

SPELTER.

	£	s.	d.
Ordinary	38	6	3
Remelted	37	0	0
Hard	32	10	0
Electro 99.9	43	0	0
English	39	0	0
India	33	10	0
Zinc dust	46	0	0
Zinc ashes	15	0	0
Off. aver., Nov.	38	13	5 1/16
Aver., spot, Nov.	39	0	9½

LEAD.

	£	s.	d.
Soft foreign ppt.	34	5	0
English	36	0	0
Off. average, Nov.	36	10	10
Average spot, Nov.	36	17	5½

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	46	0	0
Do. V.M. ex whf.	45	0	0
Rods	52	0	0
Boiler plates	44	0	0
Battery plates	44	10	0

ANTIMONY.

	£	s.	d.
Special brands, Eng.	95	0	0
Chinese	87	0	0
Crude	65	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	15	0	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

	£	s.	d.
Ferro silicon 25%	9	10	0
45/50%	11	15	0
75%	21	10	0
Ferro-vanadium— 35/40%	15/3 lb. va.		
Ferro-molybdenum— 70/75% c. free 6/- to 6/3 lb.			
Ferro-titanium— 23/25% carbonless	1/1 lb.		
Ferro-phosphorus, 20/25%,	£20	0	0
Ferro-tungsten— 80/85%, c.fr.	1/8 lb. to 1/8½		
Tungsten metal powder— 98/99%	1/11 to 2/- lb.		
Ferro-chrome— 2/4% car.	£34	15	0
4/6% car.	£23	12	6
6/8% car.	£23	2	6
8/10% car.	£22	15	0
Ferro-chrome— Max. 2% car.	£40	15	0
Max. 1% car.	£49	0	0
Max. 0.70% car.	£56	10	0
70%, carbonless	1/5 lb.		
Nickel—99%, cubes or pellets	£172 to £177		
Cobalt metal—98/99%	10/- lb.		
Aluminium 98/99%	£120		
Metallic Chromium— 96/98%	3/6 lb.		
Ferro-manganese (net)— 76/80%, loose	£15	7	6
76/80%, packed	£16	7	6
76/80%, export	£15	5	0
Metallic manganese— 94/96%, carbonless	2/- lb.		

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	s.	d.
Finished bars, 14% tungsten	2	6
Finished bars, 18% tungsten	3	0

Per lb. net, d/d buyers' works.

Extras—
Rounds and squares 3 in. and over — 4d. lb.
Rounds and squares under ½ in. to ¼ in. — 3d. lb.
Do. under ¼ in. to 3/16 in. — 1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅜ in. — 3d. lb.
Do. under ½ in. × ¼ in. — 1/- lb
Bevels of approved sizes and sections — 6d. lb.
Bars cut to length 10% extra
Scrap from high-speed tool steel—
Scrap pieces — 3d.
Turningds andwarf — 1d.
Per lb. net, d/s steel makers' work

SCRAP.

	£	s.	d.	£	s.	d.
South Wales— Hvy. steel	3	7	6	3	10	0
Bundled steel & shrngs.	3	2	6	to 3	6	0
Mixed iron & steel	3	0	0	to 3	2	6
Heavy cast iron	3	2	6	to 3	5	0
Good machinery for foundries		3	7	6		
Cleveland— Heavy steel		3	2	6		
Steel turnings		2	5	0		
Cast iron borings		2	2	6		
Heavy forge		4	2	6		
Bushelled scrap		3	7	6		
Cast-iron scrap	3	0	0	to 3	1	0
Lancashire— Cast-iron scrap		3	10	0		
Heavy wrought		3	7	6		
Steel turnings		2	0	0		
London — Merchants' buying prices delivered yard.						
Copper (clean)		52	0	0		
Brass (clean)		39	0	0		
Lead (less usual draft)		31	0	0		
Tea lead		27	0	0		
Zinc		25	0	0		
New aluminium cuttings		92	0	0		
Braziery copper		46	0	0		
Gunmetal		46	0	0		
Hollow pewter		195	0	0		
Shaped black pewter		142	0	0		

PIG-IRON.

(f.o.t. unless otherwise stated).

N.E. Coast— Foundry No. 1	69/-
Foundry No. 3	66/6
Foundry No. 4	65/6
Forge No. 4	65/-
Hematite No. 1	76/6
Hematite M/Nos.	76/-
N.W. Coast— Hem. M/Nos. d/d Glas.	85/-
,, d/d Birm.	92/6
Midlands— Staffs common*	—
,, No 4 forge	59/6
,, No. 3 foundry	65/-
Shrops. basic	70/-
,, Cold blast, ord.*	185/-
,, ,, roll iron*	190/-
* d/d Birmingham.	
Northants forge	55/9
,, fdry No. 3	62/6
Derbyshire forge	59/6
,, fdry. No. 3	65/-
,, basic	65/-
Scotland— Foundry No. 1	82/-
,, No. 3	77/-
Hem. M/Nos.	77/6
Sheffield (d/d district)— Derby forge	63/6
,, fdry. No. 3	69/-
Lincs. forge	68/-
,, fdry. No. 3	70/-
E.C. hematite	86/6
W.C. hematite	88/6
Lincs. (at furnaces)— Forge No. 4	62/-
Foundry No. 3	64/-
Basic	64/-
Lancashire (d/d eq. Man.)— Derby forge	67/-
,, fdry. No. 2	73/-
Northants foundry No. 3	75/3
Dalzell, No. 3	110/-
Summerlee, No. 3	94/6
Glengarnock, No. 3	94/6
Gartsherrie, No. 3	94/6
Monkland No. 3	94/6
Coltness, No. 3	94/6
Shotts, No. 3	94/6

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars (cr.)	11	5	0	to 12	10	0
Angles		11	10	0		
Tees to 3 united ins.		12	0	0		
Nut and bolt		11	0	0		
Hoops	14	0	0	to 15	0	0
Marked bars (Staffs.) f.o.t.		14	0	0		
Gas strip	12	10	0	to 12	15	0
Bolts and nuts ¾ in. × 4 in.		16	15	0		
Steel— Ship plates	7	5	0	to 8	7	6
Boiler plts.		11	10	0		
Chequer plts.	£9	5	0	to 9	15	0
Angles	£7	0	0	to 7	5	0
Tees	£8	0	0	to 8	5	0
Channels	£6	12	6	to 7	2	6
Joists	£7	0	0	to 7	5	0
Rounds and Squares 3 in. to 5½ ins.		8	5	0		
Rounds under 3 in. to ⅜ in.		8	0	0		
Flats, over 5 in. wide and up		8	15	0		
Flats, 5in. to 1½in.		7	15	0		
Rails, heavy		8	0	0		
Fishplates		12	0	0		
Hoops (Staffs.)		10	10	0		
Black sheets, 24g.		11	5	0		
Galv. cor. sheets, 24g.		16	15	0		
Galv. fencing wire 8g. plain		14	0	0		
Billets, soft	£6	0	0	to 7	10	0
Billets, hard		8	2	6		
Sheet bars		6	5	0		
Tin bars d/d		6	5	0		

PHOSPHOR BRONZE.

	Per lb.	basis.
Strip	1	3
Sheet to w.g.	1	3½
Wire	1	3¾
Rods	1	3
Tubes	1	8½
Castings	1	2

Delivery 3 cwt. free
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	9d. to 1/3
Rolled— To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/- to 1/8½
Wire round— 3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge.

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	24.26
No. 2 foundry, Valley	22.26
No. 2 foundry, Birm.	22.00
Basic	21.76
Bessemer	22.76
Malleable	22.26
Grey forge	21.76
Ferro-mang. 80% d/d	115.00
Bess. rails, h'y, at mill	43.00
O.-h. rails, h'y at mill	43.00
Bess billets	35.00
O.-h. billets	35.00
O.-h. sheet bars	36.00
Wire rods	45.00
	Cents.
Iron bars, Phila.	2.22
Steel bars	2.00
Tank plates	1.90
Beams, etc.	1.90
Skelp, grooved steel	1.90
Skelp, sheared steel	1.90
Steel hoops	2.50
Sheets, black, No. 28	3.35
Sheets, galv., No. 28	4.60
Sheets, blue an'l'd, 9 & 10	2.50
Wire nails	2.65
Plain wire	2.50
Barbed wire, galv.	3.35
Tinplate, 100 lb. box	$5.50

COKE (at ovens).

Welsh foundry — 32/6 to 37/6
,, furnace — 20/- to 25/-
Durham & North.
,, foundry — 30/- to 33/-
,, furnace — 17/6
Other Districts, foundry — 30/- to 33/-
,, ,, furnace (basis) — 11/9

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes, 20 × 14, box		20/-
,,	28 × 20, ,,	40/-
,,	20 × 10, ,,	29/3
,,	18¾ × 14, ,,	20/10½
C.W.	20 × 14, ,,	18/3
,,	28 × 20, ,,	36/4½
,,	20 × 10, ,,	25/1½
,,	18¾ × 14, ,,	18/7½

Terneplates 28 × 20, 36/- per box basis f.o.b.

SWEDISH IRON.

Bars, hammered £19/0 to £20/0
Rolled Ord. £16/0/0 to £16/10/0
Nail rods £16 5 0 to £16 15 0
Keg. steel nom. — £33 to £35
Faggot steel nom. — £22 to £25
Blooms, according to quality — £10 to £14
Pig-iron £6 15 0 to £7 0 0 all f.o.b. Gothenburg.

TUBES.

Up to and incl. 6 in.

Gas .. 55% } Tube prices
Water .. 50% } are
Steam .. 45% } now free.

Electrolytic Copper.

	£	s.	d.		
Dec. 17	65	10	0	inc.	10/-
,, 18	66	0	0	,,	10/-
,, 21	66	5	0	,,	5/-
,, 22	66	5	0	No change	

Tin (English ingots).

	£	s.	d.		
Dec. 17	279	15	0	inc.	95/-
,, 18	281	0	0	,,	25/-
,, 21	285	0	0	,,	80/-
,, 22	285	0	0	No change	

Spelter (ordinary).

	£	s.	d.		
Dec. 17	38	3	8	inc.	8/9
,, 18	38	10	0	,,	6/3
,, 21	38	8	9	dec.	1/3
,, 22	38	6	3	,,	2/6

DAILY FLUCTUATIONS.

Standard Copper (Cash).

	£	s.	d.		
Dec. 17	59	12	6	inc.	7/6
,, 18	60	0	0	,,	7/6
,, 21	60	5	0	,,	5/-
,, 22	60	0	0	dec.	5/-

Standard Tin (Cash).

	£	s.	d.		
Dec. 17	280	15	0	inc.	95/-
,, 18	281	15	0	,,	20/-
,, 21	286	0	0	,,	85/-
,, 22	285	10	0	dec.	10/-

Zinc Sheets (English).

	£	s.	d.		
Dec. 17	46	0	0	No change	
,, 18	46	0	0	,,	,,
,, 21	46	0	0	,,	,,
,, 22	46	0	0	,,	,,

Lead (English).

	£	s.	d.		
Dec. 17	36	0	0	inc.	10/-
,, 18	36	0	0	No change	
,, 21	36	0	0	,,	,,
,, 22	36	0	0	,,	,,

BLAST-FURNACE STATISTICS.

Furnaces in Blast at the close of each Quarter making Pig-iron Specified.

Quarter ending.	Hematite.	Forge and foundry.	Basic.	Ferro-manganese	Total in blast.
1912					
March ..	16	26	7	6	55
June ..	103	163	47	12	325
September	113	170	49	15	347
December ..	115	171	49	15	350
1913					
March ..	118 2/3	169	52	18 1/3	358
June ..	117	163	50	14	344
September	107	157	47	13	324
December ..	91	154	55	13	293
1914					
March ..	96	146	47	11	300
June ..	90	143	45	12	290
September	94	133	41	15	286
December ..	100	136	46	12	294
1915					
March ..	102	130	52 2/3	10	294
June ..	103	126 1/3	54 2/3	10	294
September	105	117 1/3	52 2/3	11	287
December ..	108	111 1/3	50 2/3	15	284
1916					
March ..	116	106 1/3	50 2/3	12	285
June ..	120	106	54	13	293
September	124	107	58	13	302
December ..	126	110	57	18	311
1917					
March ..	131	111	62	16	320
June ..	129	116	70	15	324
September	123	102	78	19	322
December ..	118	99	85	13	315
1918					
March ..	117	102	92	15	326
June ..	120	108	86	16	330
1918					
September	120	104	83	14	321
December ..	113	108	72	15	308

Quarter ending.	Hematite.	Forge and foundry.	Basic.	Ferro-manganese	Total in blast.
1919					
March ..	98	109	69	13	289
June ..	97	107	78	7	289
September	66	99	53	5	223
December ..	77	113	62	8	260
1920					
March	92	108	72	10	282
June ..	97	119	68	12	296
September	93	122	73	12	300
December ..	77	125	59	13	274
1921					
March ..	36	70	10	3	119
June ..	—	1	—	—	1
September	17	41	10	—	68
December ..	22	41	15	3	81
1922 ..					
March ..	31	46	23	7	107
June ..	25	55	28	9	117
September	27	74	27	10	138
December ..	46	83 1/3	30 2/3	10	170
1923					
March ..	52	93	45	10	200
June ..	62	103	45	13	223
September	38	98	42	11	189
December ..	50	99	49	9	207
1924 ..					
March ..	45	94 2/3	51 1/3	10	201
June ..	45	91	46	8	190
September	44	85	38	5	172
December ..	42	87	31	7	167
1925 ..					
March ..	40	84	36	9	169
June ..	31	76	32	9	148
September	28	67	30	5	130

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

18, BENNETTS HILL, BIRMINGHAM.
11, OLD HALL STREET, LIVERPOOL.
EXCHANGE BLDGS., PORT TALBOT.
FOWLERS BUILDINGS, BOMBAY.
CLIVE STREET, CALCUTTA.
ANGAPPA NAICK STREET, MADRAS.

REGISTERED TRADE MARK

1, HONG KONG ROAD, SHANGHAI.
OCEAN BUILDING, SINGAPORE.
JAVA STREET, KUALA LUMPUR
5, SHAFFRAZ ROAD, RANGOON.
COX'S BUILDINGS, KARACHI.
P.O. BOX 1580, CAIRO.

PIG IRON

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.,

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM COLVIN & COMPANY,

ROYAL EXCHANGE, MIDDLESBROUGH.

93, HOPE STREET, GLASGOW.

SMALL ADVERTISEMENTS.

Notice.

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 7 words per line. Minimum charge for one insertion 3/-.

SITUATIONS VACANT AND WANTED.

STEEL FOUNDRY MANAGER AND METALLURGIST, desirous change; seven years present position; excellent Foundry record; experienced Tropenas Converter and Siemens.—Box 552, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

CHARGEHAND wanted for Modern Brass Foundry in South Midlands; must be fully experienced in the economical production of large and complicated Gun-metal Castings. — Apply, stating age, wages required and fullest details of experience, to Box 550, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

WELL - KNOWN LANCASHIRE FOUNDRY MANAGER desires change; first-class practical man, accustomed to large output Electrical, Turbines, Diesel and General Engine Castings up to 35 tons; well up in modern practice; excellent Cupola and Metallurgical knowledge; 15 years' experience as manager; good organiser, good control; accustomed piecework; excellent references; age 43 years; or would entertain offer from Foundry Requisite firms. —Apply Box 564, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

CHEMIST AND METALLURGIST, with many years' practical Foundry experience, desires post in connection with Foundry; highest references. —Apply Box 566, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi London, W.C.2.

STEEL FOUNDRY MANAGER; disengaged; experienced with the following plants: Siemens, Tropenas, Stock Oil Converter, and eight years' experience with the Electric Furnace Process; understanding the manufacture of Steel Castings from A to Z at a very keen cost of production, either piecework or timework; having also a fair connection; excellent references.—Box 568, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

EX-OFFICERS AND OTHER RANKS.

The Proprietors of the FOUNDRY TRADE JOURNAL have placed this space at the disposal of the British Legion, Officers' Association, Employment Bureau, 3-4, Clement's Inn, Strand, London, W.C.2. (telephone: Holborn 5769), to whom all replies should be addressed, quoting number of advertisement, date on which it appeared, and the name of this paper.

EX-QUARTERMASTER seeks situation as Secretary, Steward, Storekeeper, or any position of trust. (1090.)

BUSINESS OR SECRETARIAL.—Ex-Captain, fluent German and French, good Spanish, some years' business experience Germany and France; take charge French correspondence, translate books, etc., travel Continent; engineering knowledge; accept full or part-time employment, any capacity. (3297.)

EX-RANKER OFFICER, age 54, desires Clerical post or any position of trust; long experience of Army accounts, also good knowledge of commercial book-keeping; very accurate at figures; moderate salary; employment first consideration. (Dis. 46.)

REPRESENTATIVE, age 32, well educated, hard-working, honest, desires position giving chance of promotion on results. (Dis. 44.)

WELL-EDUCATED MAN, age 43, widely travelled, good business training, seeks post as Office Manager or Confidential Secretary to firm, society, or private individual; highest references. (1135.)

MACHINERY.

WANTED, Crucible Furnace, Coke fired, up to 100 or 150 lbs.; tilting type preferred; any make. —Full particulars and lowest price to Box 560, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

TWO OSBORN ROLLOVER JOLTERS, 40 in. x 50 in. size; new; exceptional opportunity; £250 each.—Box 556, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

MACHINERY.—*Continued.*

FOR SALE.—20-in. and 24-in. Hall's Invincible Sand Mixers; the original and best machine in the market for mixing old and new Foundry Sand, Coal Dust, etc.—Apply, PENNEY & PORTER (ENG.), LTD., Lincoln.

SAND MIXERS.—New and second-hand. Ask us to quote.—W. BREALEY & COMPANY, LTD., Russell Street, Sheffield.

MACHINERY, PLANT, &c.

New 16-in. stroke HIGH-SPEED SLOTTING MACHINE, by Wilkinson, admits in diameter 5 ft.

24-in. stroke TRAVERSING HEAD SHAPING MACHINE on 8-ft. bed, two tables 24 in. x 18 in. x 16 in. deep.

No. 70½ INTERNAL GRINDING MACHINE, by Heald Machine Company, capacity 15 in. swing, 11 in. long.

SET OF GUILLOTINE SHEARS, by J. Hand & Son, style C.D. No. 3, 36-in. blade to cut 3/16 in. thick.

LANCASHIRE BOILER, 30 ft. x 7 ft. 6 in. dia., reinsure 120 lbs. pressure.

Very good second-hand VERTICAL CROSS-TUBE BOILER, 14 ft. high x 6 ft. dia., reinsure 110 lbs. working pressure.

CATALOGUE (10,000 LOTS) ON APPLICATION.

THOS W. WARD, LTD.,
ALBION WORKS, SHEFFIELD.

MISCELLANEOUS.

PATTERNS.—Inquiries solicited; quotations by return; shop equipped with modern machinery; quick delivery.—CLEGHORN & COMPANY, Midland Pattern Works, Spring Gardens, Worcester. Phone 264.

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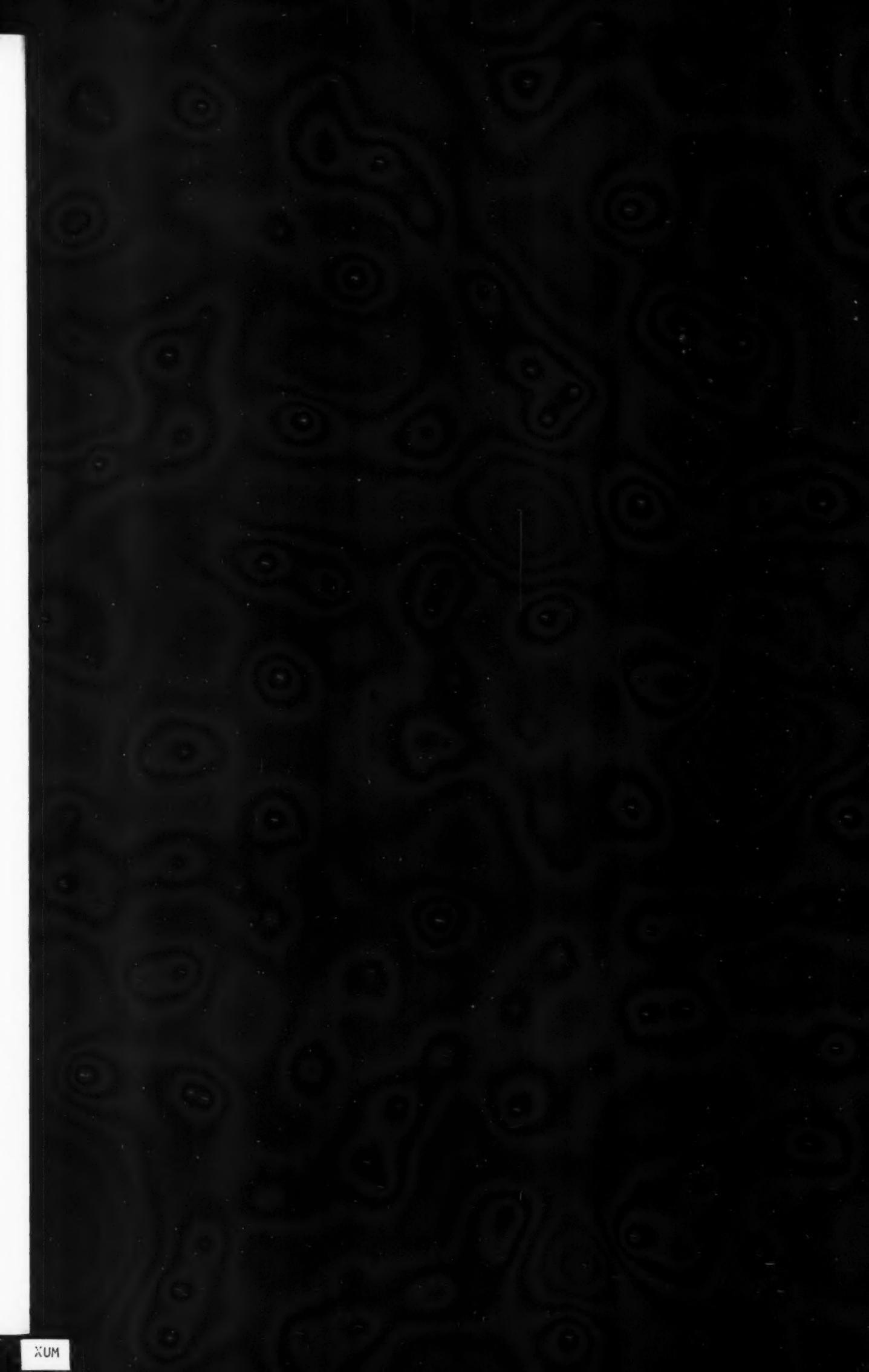

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